Raspberry Pi Compute Module 4

A Raspberry Pi for deeply embedded applications

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Colophon

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1.1. Introduction

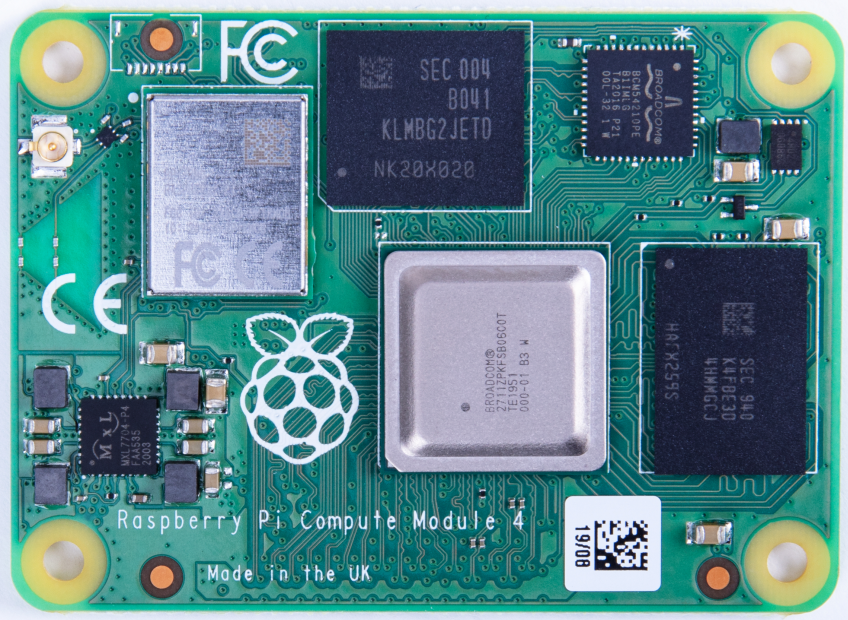


Figure 1. The Raspberry Pi Compute Module 4 (CM4).

The Raspberry Pi Compute Module 4 (CM4) is a System on Module (SoM) containing processor, memory, eMMC Flash, and supporting power circuitry. These modules allow a designer to leverage the Raspberry Pi hardware and software stack in their own custom systems and form factors. In addition, these modules have extra IO interfaces over and above what is available on the Raspberry Pi boards, opening up more options for the designer.

The design of the CM4 is loosely based on the Raspberry Pi 4 Model B, and for cost-sensitive applications it can be supplied without the eMMC fitted; this version is called the Raspberry Pi Compute Module 4 Lite (CM4Lite).

While previous generations of the Compute Module have all shared the same DDR2-SODIMM-mechanically-compatible form factor, the new CM4 and CM4Lite are different. The electrical interface of the CM4 is via two 100-pin high density connectors, and the new physical form factor has a smaller footprint overall when the connectors are taken into account.

This change is due to the addition of new interfaces: an additional second HDMI, PCIe, and Ethernet. The addition of these new interfaces, especially PCIe, would not have been possible while preserving the previous form factor.

NOTE

Unless otherwise stated, for this document CM4 also refers to CM4Lite.

1.2. Features

Key features of the CM4 are as follows:

- Broadcom BCM2711, quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
- Small Footprint 55mm × 40mm × 4.7mm module
  - 4 × M2.5 mounting holes

第 1 章节。简介

1.1. 介绍

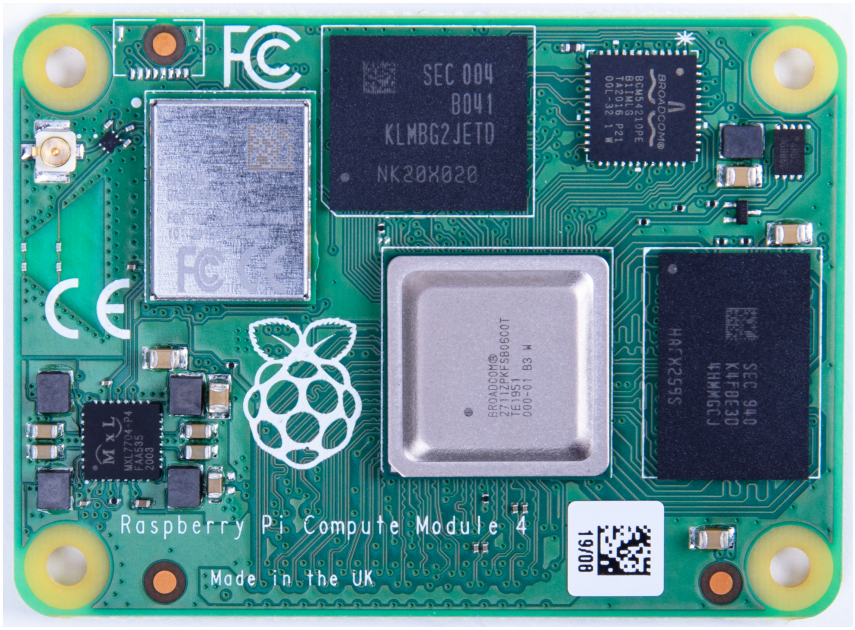


图 1. Raspberry Pi 计算模块 4（CM4）。

Raspberry Pi 计算模块 4 (CM4) 是一款系统级模块（SoM），包含处理器、内存、eMMC 闪存及支持电源电路。这些模块使设计者能够在自身定制的系统及外形尺寸中，利用 Raspberry Pi 硬件及软件生态。此外，这些模块在 Raspberry Pi 主板基础上提供额外的输入输出接口，拓展了设计者的选择范围。

CM4 的设计松散基于 Raspberry Pi 4 型 B，对于成本敏感应用，可提供无 eMMC 的版本；该版本称为 Raspberry Pi 计算模块 4 Lite（CM4Lite）。

尽管前代计算模块均采用相同的 DDR2-SODIMM 机械兼容外形规格，全新 CM4 与 CM4Lite 设计有所不同。CM4 的电气接口通过两个 100 针高密度连接器实现，考虑连接器后新物理外形尺寸整体更小。

此变化源于新增接口：第二个 HDMI、PCIe 和以太网。尤其是 PCIe 的引入，若保持先前外形尺寸则无法实现。

注意

除非另有说明，本文件中 CM4 亦指 CM4Lite。

1.2. 特性

CM4 的主要特性如下：

- 博通 BCM2711，四核 Cortex-A72（ARM v8）64 位系统级芯片，主频 1.5GHz
- 小型封装 55mm×40mm×4.7mm 模块
  - 4 个 M2.5 安装孔

- H.265 (HEVC) (upto 4Kp60 decode), H.264 (upto 1080p60 decode, 1080p30 encode)
- OpenGL ES 3.0 graphics
- Options for 1GB, 2GB, 4GB or 8GB LPDDR4-3200 SDRAM with ECC (see Appendix B)
- Options for 0GB **(CM4Lite)**, 8GB, 16GB, or 32GB eMMC flash memory (see Appendix B)
  - Peak eMMC bandwidth 100MBps (four times faster than previous Compute Modules)
- Option (see Appendix B) for certified radio module with:
  - 2.4 GHz, 5.0 GHz IEEE 802.11 b/g/n/ac wireless
  - Bluetooth 5.0, BLE
  - On board electronic switch to select between PCB trace or external antenna
- Gigabit Ethernet PHY supporting IEEE 1588
- 1 × PCIe 1-lane Host, Gen 2 (5Gbps)
- 1 × USB 2.0 port (high speed)
- 28 × GPIO supporting either 1.8V or 3.3V signalling and peripheral options:
  - Up to 5 × UART
  - Up to 5 × I2C
  - Up to 5 × SPI
  - 1 × SDIO interface
  - 1 × DPI (parallel RGB display)
  - 1 × PCM
  - Up to 2× PWM channels
  - Up to 3× GPCLK outputs
- 2 × HDMI 2.0 ports (up to 4Kp60 supported)
- MIPI DSI:
  - 1 × 2-lane MIPI DSI display port
  - 1 × 4-lane MIPI DSI display port
- MIPI CSI-2:
  - 1 × 2-lane MIPI CSI camera port
  - 1 × 4-lane MIPI CSI camera port
- 1 × SDIO 2.0 **(CM4Lite)**
- Single +5V PSU input.

- H.265（HEVC）（最高支持 4Kp60 解码），H.264（最高支持 1080p60 解码，1080p30 编码）
- OpenGL ES 3.0 图形
- 提供1GB、2GB、4GB或8GB带ECC的LPDDR4-3200 SDRAM选项（见附录B）
- 提供0GB（**CM4Lite**）、8GB、16GB或32GB eMMC闪存选项（见附录B）
  - 峰值 eMMC 带宽为100MBps（比之前的计算模块快四倍）
- 认证无线电模块选项（见附录B），包括：
  - 2.4 GHz、5.0 GHz IEEE 802.11 b/g/n/ac无线
  - 蓝牙5.0，低功耗蓝牙（BLE）
  - 板载电子开关，用于选择PCB走线或外部天线
- 支持IEEE 1588协议的千兆以太网PHY
- 1×PCIe单通道主机，Gen 2（5Gbps）
- 1×高速USB 2.0端口
- 28×GPIO，支持1.8V或3.3V信号及外设选项：
  - 最多5×UART 通用异步收发器
  - 最多5个I2C接口
  - 最多5个SPI串行外设接口
  - 1个SDIO接口
  - 1个DPI（并行RGB显示）
  - 1个PCM接口
  - 最多2个PWM通道
  - 最多3个GPCLK输出
- 2个HDMI 2.0端口（支持最高4Kp60）
- MIPI DSI:
  - 1个2通道MIPI DSI显示端口
  - 1个4通道MIPI DSI显示端口
- MIPI CSI-2:
  - 1个2通道MIPI CSI摄像头端口
  - 1个4通道MIPI CSI摄像头端口
- 1**个**SDIO 2.0**接口（ CM4Lite）**
- 单路+5V电源输入。

Chapter 2. Interfaces

2.1. Wireless

The CM4 can be supplied with an on-board wireless module based on the Cypress CYW43455 supporting both:

- 2.4 GHz, 5.0 GHz IEEE 802.11 b/g/n/ac wireless
- Bluetooth 5.0, BLE

These wireless interfaces can be individually enabled or disabled as required. For instance, in the case of a kiosk application, a service engineer could enable wireless operation and then disable it once finished.

The CM4 has an on-board antenna. If used it should be positioned in the product such that it is not surrounded by metal, including any ground plane (see Chapter 3 for further details). Alternatively there is a standard U.FL connector on the module, see Figure 1, so that an external antenna can be used.

Raspberry Pi Ltd has an antenna kit which is certified to be used with the CM4. If a different antenna is used then separate certification will be required.

WARNING

Raspberry Pi Ltd will not be able to assist with certification for third-party antennas.

The selection of internal or external antenna is done at boot time using the `config.txt` file, and can not be changed during operation. The `config.txt` options are `dtparam=ant1` to select the internal antenna, or `dtparam=ant2` for the external antenna.

2.1.1. `WL_nDisable`

This pin serves a number of functions;

1. It can be used to monitor the enable/disable state of wireless networking. A logic high means the wireless networking module is powered up.
2. When driven or tied low it prevents the wireless network module from powering up. This is useful to reduce power consumption or in applications where it is required to physically ensure the wireless networking is disabled. If the interface is enabled after being disabled, the wireless interface driver needs reinitialised.

NOTE

On CM4 modules without wireless, this pin is reserved.

2.1.2. `BT_nDisable`

This pin serves a number of functions;

1. It can be used to monitor the enable/disable state of Bluetooth. A logic high means the Bluetooth module is powered up.
2. When driven, or tied low, it prevents the Bluetooth module from powering up. This is useful to reduce power consumption, or in applications where it is required to physically ensure the Bluetooth is disabled. If the interface is enabled after being disabled, the Bluetooth interface driver needs reinitialised.

第2章节 接口

2.1. 无线

CM4可配备基于Cypress CYW43455的板载无线模块，支持以下功能：

- 2.4 GHz、5.0 GHz IEEE 802.11 b/g/n/ac无线
- 蓝牙5.0，低功耗蓝牙（BLE）

这些无线接口可根据需求单独启用或禁用。例如，在自助服务终端应用中，服务工程师可启用无线功能，完成后再将其禁用。

CM4配备板载天线。如使用此天线，应将其安置在产品中不被金属包围的位置，包括任何接地平面（详见第3章节）。 此外，模块上设有标准U.FL连接器（见图1），以便连接外部天线。

Raspberry Pi Ltd提供的天线套件经过CM4使用认证。如采用其他天线，则需单独取得认证。

警告

Raspberry Pi Ltd无法协助第三方天线的认证事宜。

内置或外置天线的选择通过 `config.txt`文件在启动时完成，运行期间不可更改。config.txt的选项为dtparam=ant1选择内置天线，或`dtparam=ant2`选择外置天线。

2.1.1. `WL_nDisable`

该引脚具有多种功能；

1. 可用于监测无线网络的启用/禁用状态。逻辑高电平表示无线网络模块已上电。

2. 当被驱动或拉低时，阻止无线网络模块上电。这对于降低功耗或在需要物理确保无线网络被禁用的应用中非常有用。若接口在禁用后重新启用，则需重新初始化无线接口驱动程序。

注意

对于无无线功能的 CM4 模块，此引脚保留。

2.1.2. `BT_nDisable`

该引脚具有多种功能；

1. 可用于监测蓝牙的启用/禁用状态。逻辑高电平表示蓝牙模块已上电。

2. 当被驱动或拉低时，阻止蓝牙模块上电。这对于降低功耗或在需要物理确保蓝牙被禁用的应用中非常有用。若接口在禁用后重新启用，则需重新初始化蓝牙接口驱动程序。

NOTE

On CM4 modules without wireless, this pin is reserved.

2.2. Ethernet

The CM4 has an on-board Gigabit Ethernet PHY — the Broadcom BCM54210PE — some of the major features of this PHY include;

- IEEE 1588-2008 compliant
- MDI crossover, pair skew and pair polarity correction

A standard 1:1 RJ45 MagJack is all that is necessary to provide an Ethernet connection to the CM4. Typical wiring of a MagJack supporting PoE, and with added ESD protection, can be seen in Figure 2.

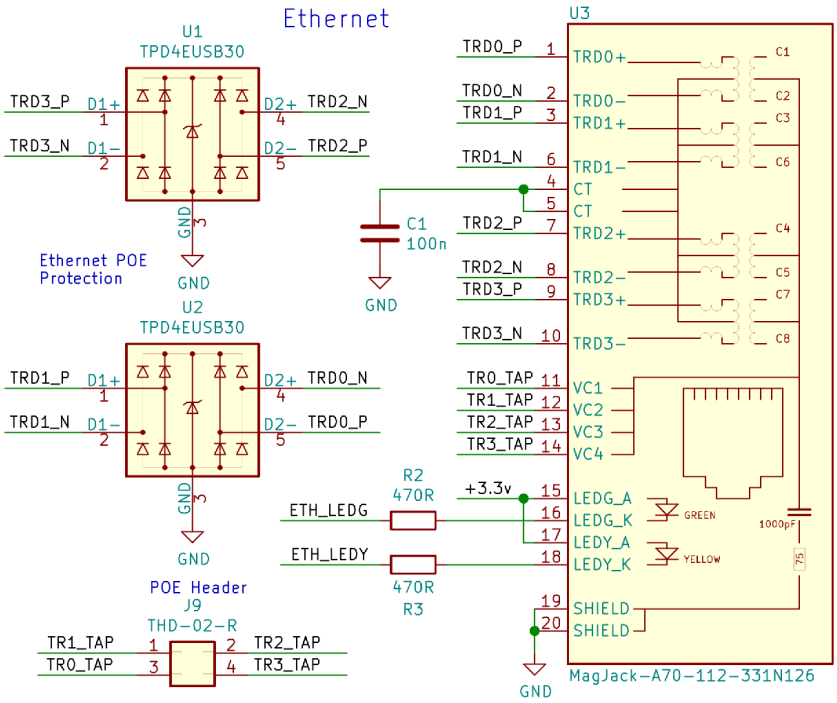


Figure 2. Ethernet schematic interface for the Raspberry Pi Compute Module 4 supporting PoE, and with added ESD protection.

The differential Ethernet signals should be routed as 100Ω differential pairs, with suitable clearances. Length matching between pairs should be better than 50mm, so in the typical case no length matching is required. However the signals within a pair need to be length matched, ideally to better than 0.15mm.

The PHY also supports up to 3 LEDs to give user status feedback, these are low active. These LEDs can have a range of functions, and you should consult your OS driver to see which functions are supported by your driver.

The PHY also provides `SYNC_IN` and `SYNC_OUT` at 3.3V signalling to support IEEE 1588-2008.

2.3. PCIe (Gen2 x1)

The CM4 has an internal PCIe 2.0 x1 host controller. While on the Raspberry Pi 4 Model B this has been connected to a USB 3 host controller (using the Via Labs VLI805), on the CM4 the product designer is free to choose how the interface is used.

注意

对于无无线功能的 CM4 模块，此引脚保留。

2.2. 以太网

CM4 内置了千兆以太网 PHY —— Broadcom BCM54210PE，该 PHY 的主要特性包括：

- 符合 IEEE 1588-2008 标准
- 支持 MDI 交叉、对间时序偏移和对极性校正

只需一个标准的 1:1 RJ45 MagJack 即可为 CM4 提供以太网连接。支持 PoE 并附加 ESD 保护的 MagJack 典型接线见图 2。

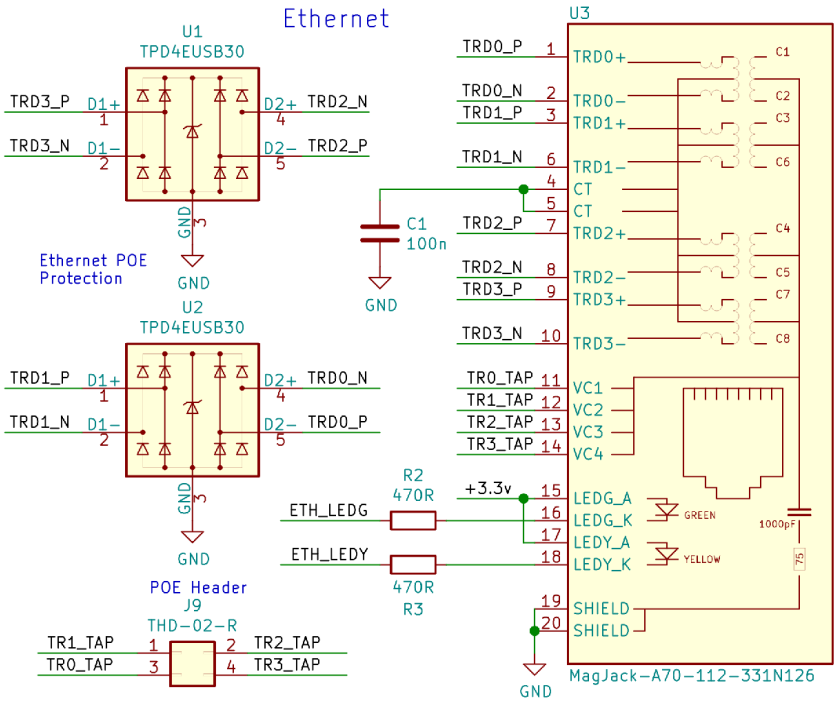


图 2。 支持 *PoE* 并附加 *ESD* 保护的 *Raspberry Pi* 计算模块 *4* 以太网接口示意图。

以太网差分信号应作为 100Ω 差分对布线，且保持适当间距。差分对间的长度匹配应优于 50mm，因此在一般情况下无需特别调整长度。但对内信号需要严格长度匹配，理想情况下应优于 0.15mm。

该 PHY 还支持最多 3 个低电平有效的 LED 指示灯，用于提供用户状态反馈。这些LED可以具备多种功能，您应参考操作系统驱动以确认驱动支持的功能。

PHY还提供3.3V信号的 `SYNC_IN`和 `SYNC_OUT`以支持IEEE 1588-2008。

2.3. PCIe (Gen2 x1)

CM4配备一个内部PCIe 2.0 x1主机控制器。虽然在Raspberry Pi 4 型 B中，该控制器连接至USB 3主机控制器（采用Via Labs VLI805），但在CM4上，产品设计者可自由选择接口的使用方式。

WARNING

You should ensure that there is a suitable OS driver for any host controller that is chosen before proceeding to a prototype.

NOTE

The on-board PCIe Host controller doesn't support 64-bit accesses from the ARM, they must be split up into two 32-bit accesses.

Connecting a PCIe device follows the standard PCIe convention. The CM4 has on-board AC coupling capacitors for `CLK` and `PCIe_TX` signals. However the `PCIe_RX` signals need external coupling capacitors close to the driving source (the device `TX`), if you are using an external PCIe/NVMe card these capacitors will be on-board. The PCIe convention is that if you are wiring directly to an IC then the TX and RX pairs need to be swapped (i.e. TX → RX, RX → TX). If you are wiring to a connector then this is typically labelled from the host point of view and so TX/RX swaps aren't required. Additionally the `PCIe_CLK_nREQ` must be connected to ensure the CM4 produces a clock signal, and the `PCIe_nRST` should also be connected to ensure the device is correctly reset when required.

The differential PCIe signals should be routed as 90Ω differential pairs, with suitable clearances. There is no need to match the lengths between pairs, only the signals within a Pair need to be length matched ideally to better than 0.1mm.

TIP

5.10 kernels and newer have had support for MSI-X added. There is a limit of upto 32 IRQs available. If the device has problems with interrupts then adding `pci=nomsi` to `cmdline.txt` (and rebooting) often fixes the issue.

2.4. USB 2.0 (high speed)

The USB 2.0 interface supports up to 480Mbps signalling. The differential pair should be routed as a 90Ω differential pair. The length of the P/N signals should ideally be matched to better than 0.15mm.

TIP

The firmware disables the USB interface by default to save power. In recent versions of Raspberry Pi OS (Bullseye) it is automatically enabled by the `otg_mode=1` setting in the config.txt file. If you are using a different OS, or an older version of Raspberry Pi OS, you will need to add this to config.txt to enable the USB interface.

NOTE

The port is capable of being used as a true USB On-The-Go (OTG) port. While there is no official documentation, some users have had success making this work. The `USB_OTG_ID` pin is used to select between USB host and device that is typically wired to the ID pin of a Micro USB connector. To use this functionality it must be enabled in the OS. If using either as a fixed slave or fixed master, please tie the `USB_OTG_ID` pin to ground.

2.5. GPIO

There are 28 pins available for general purpose I/O (GPIO), which correspond to the GPIO pins on the Raspberry Pi 4 Model B 40-pin header. These pins have access to internal peripherals: SMI, DPI, I2C, PWM, SPI, and UART. The BCM2711 ARM peripherals book describes these features in detail, along with the multiplexing options available. The drive strength and slew rate should ideally be set as low as possible to reduce any EMC issues. GPIO2 and GPIO3 have 1.8kΩ pull up resistors.

The BCM2711 GPIO bank is powered by `GPIO_VREF`, this can either be connected to +1.8V for 1.8V signalling GPIO, or

警告

在进行原型开发之前，您应确保所选主机控制器有适配的操作系统驱动支持。

注意

板载PCIe主机控制器不支持ARM的64位访问，必须将其拆分为两个32位访问。
位访问。

连接PCIe设备遵循标准PCIe规范。CM4板载CLK和PCIe_TX信号配备了交流耦合电容。然而，PCIe_RX信号需要在靠近驱动源（设备TX）处使用外部耦合电容；如果您使用的是外部PCIe/NVMe卡，这些电容将集成于板载。PCIe的惯例是：若直接连接至IC，则需要交换TX和RX对（即TX→ RX，RX→TX）；若连接至连接器，通常从主机视角标注，因此无需交换TX/RX。

此外，必须连接PCIe_CLK_nREQ以确保CM4生成时钟信号，同时应连接PCIe_nRST以确保设备在必要时正确复位。

差分PCIe信号应按90Ω差分对布线，并保持适当的间隙。无需匹配各差分对之间的长度，理想情况下仅需将同一差分对内的信号长度匹配，且最好优于0.1毫米。

提示

5.10 及更高版本的内核已增加对 MSI-X 的支持。最多支持 32 个中断请求（IRQ）。 如果设备存在中断问题，通常通过在 cmdline.txt文件中添加pci=nomsi并重启可解决此问题。

2.4. USB 2.0（高速）

USB 2.0 接口支持最高 480Mbps 的信号传输速率。差分对应布线应为 90Ω 差分阻抗。P/N 信号的长度理想匹配精度应优于 0.15mm。 提示

固件默认禁用 USB 接口以节省功耗。在 Raspberry Pi OS 最新版本（Bullseye）中，通过 config.txt 文件中的 otg_mode=1设置自动启用该功能。若使用其他操作系统或旧版 Raspberry Pi OS，需将该设置添加至 config.txt 以启用 USB 接口。

注意

该端口支持作为真正的 USB On-The-Go（OTG）端口使用。尽管没有官方文档，一些用户已成功实现此功能。USB_OTG_ID 引脚用于在 USB 主机与设备之间切换，通常连接至 Micro USB 连接器的 ID 引脚。要启用此功能，必须在操作系统内进行设置。如固定用作从设备或主设备，请将 USB_OTG_ID 引脚接地。

2.5. GPIO

共有 28 个通用输入输出（GPIO）引脚， 与 Raspberry Pi 4 型 B 40 针排针上的 GPIO 引脚对应。这些引脚可访问内部外设：SMI、DPI、I2C、PWM、SPI 串行外设接口 和 UART 通用异步收发器。BCM2711 ARM 外设手册详细介绍了这些功能及其复用选择。应尽可能将驱动强度及转换速率设为最低，以减少电磁兼容（EMC）问题。GPIO2 和 GPIO3 设有 1.8kΩ 上拉电阻。

BCM2711 GPIO 组由 GPIO_VREF供电，GPIO_VREF 可接至 +1.8V 用于 1.8V 信号，或

+3.3V for 3.3V signalling. You should keep the load on the 28 GPIO pins to below 50mA in total. `GPIO_VREF` must be powered for the CM4 to start up correctly.

2.5.1. Alternative function assignments

Up to six alternative functions are available. The BCM2711 ARM peripherals book describes these features in detail. The table below gives a quick overview.

Table 1. GPIO pins alternative function assignment

GPIO	Pull	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
GPIO0	High	SDA0	SA5	PCLK	SPI3_CE0_N	TXD2	SDA6
GPIO1	High	SCL0	SA4	DE	SPI3_MISO	RXD2	SCL6
GPIO2	High	SDA1	SA3	LCD_VSYNC	SPI3_MOSI	CTS2	SDA3
GPIO3	High	SCL1	SA2	LCD_HSYNC	SPI3_SCLK	RTS2	SCL3
GPIO4	High	GPCLK0	SA1	DPI_D0	SPI4_CE0_N	TXD3	SDA3
GPIO5	High	GPCLK1	SA0	DPI_D1	SPI4_MISO	RXD3	SCL3
GPIO6	High	GPCLK2	SOE_N / SE	DPI_D2	SPI4_MOSI	CTS3	SDA4
GPIO7	High	SPI0_CE1_N	SWE_N / SRW_N	DPI_D3	SPI4_SCLK	RTS3	SCL4
GPIO8	High	SPI0_CE0_N	SD0	DPI_D4	BSCSL / CE_N	TXD4	SDA4
GPIO9	Low	SPI0_MISO	SD1	DPI_D5	BSCSL / MISO	RXD4	SCL4
GPIO10	Low	SPI0_MOSI	SD2	DPI_D6	BSCSL SDA / MOSI	CTS4	SDA5
GPIO11	Low	SPI0_SCLK	SD3	DPI_D7	BSCSL SCL / SCLK	RTS4	SCL5
GPIO12	Low	PWM0_0	SD4	DPI_D8	SPI5_CE0_N	TXD5	SDA5
GPIO13	Low	PWM0_1	SD5	DPI_D9	SPI5_MISO	RXD5	SCL5
GPIO14	Low	TXD0	SD6	DPI_D10	SPI5_MOSI	CTS5	TXD1
GPIO15	Low	RXD0	SD7	DPI_D11	SPI5_SCLK	RTS5	RXD1
GPIO16	Low	<reserved>	SD8	DPI_D12	CTS0	SPI1_CE2_N	CTS1
GPIO17	Low	<reserved>	SD9	DPI_D13	RTS0	SPI1_CE1_N	RTS1
GPIO18	Low	PCM_CLK	SD10	DPI_D14	SPI6_CE0_N	SPI1_CE0_N	PWM0_0
GPIO19	Low	PCM_FS	SD11	DPI_D15	SPI6_MISO	SPI1_MISO	PWM0_1
GPIO20	Low	PCM_DIN	SD12	DPI_D16	SPI6_MOSI	SPI1_MOSI	GPCLK0
GPIO21	Low	PCM_DOUT	SD13	DPI_D17	SPI6_SCLK	SPI1_SCLK	GPCLK1
GPIO22	Low	SD0_CLK	SD14	DPI_D18	SD1_CLK	ARM_TRST	SDA6
GPIO23	Low	SD0_CMD	SD15	DPI_D19	SD1_CMD	ARM_RTCK	SCL6
GPIO24	Low	SD0_DAT0	SD16	DPI_D20	SD1_DAT0	ARM_TDO	SPI3_CE1_N
GPIO25	Low	SD0_DAT1	SD17	DPI_D21	SD1_DAT1	ARM_TCK	SPI4_CE1_N
GPIO26	Low	SD0_DAT2	<reserved>	DPI_D22	SD1_DAT2	ARM_TDI	SPI5_CE1_N
GPIO27	Low	SD0_DAT3	<reserved>	DPI_D23	SD1_DAT3	ARM_TMS	SPI6_CE1_N

接至 +3.3V 用于 3.3V 信号。应将 28 个 GPIO 引脚的总负载保持在 50mA 以下。 GPIO_VREF必须供电，CM4 才能正确启动。

2.5.1. 备用功能分配

最多支持六种备用功能。BCM2711 ARM 外设手册对这些功能进行了详细描述。下表提供快速概览。

表 1. GPIO 引脚备用功能分配

GPIO	上下拉	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
GPIO0	高	SDA0	SA5	PCLK	SPI3_CE0_N	TXD2	SDA6
GPIO1	高	SCL0	SA4	DE	SPI3_MISO	RXD2	SCL6
GPIO2	高	SDA1	SA3	LCD_VSYNC	SPI3_MOSI	CTS2	SDA3
GPIO3	高	SCL1	SA2	LCD_HSYNC	SPI3_SCLK	RTS2	SCL3
GPIO4	高	GPCLK0	SA1	DPI_D0	SPI4_CE0_N	TXD3	SDA3
GPIO5	高	GPCLK1	SA0	DPI_D1	SPI4_MISO	RXD3	SCL3
GPIO6	高	GPCLK2	SOE_N / SE	DPI_D2	SPI4_MOSI	CTS3	SDA4
GPIO7	高	SPI0_CE1_N	SWE_N / SRW_N	DPI_D3	SPI4_SCLK	RTS3	SCL4
GPIO8	高	SPI0_CE0_N	SD0	DPI_D4	BSCSL / CE_N	TXD4	SDA4
GPIO9	低	SPI0_MISO	SD1	DPI_D5	BSCSL / MISO	RXD4	SCL4
GPIO10	低	SPI0_MOSI	SD2	DPI_D6	BSCSL SDA / MOSI	CTS4	SDA5
GPIO11	低	SPI0_SCLK	SD3	DPI_D7	BSCSL SCL / SCLK	RTS4	SCL5
GPIO12	低	PWM0_0	SD4	DPI_D8	SPI5_CE0_N	TXD5	SDA5
GPIO13	低	PWM0_1	SD5	DPI_D9	SPI5_MISO	RXD5	SCL5
GPIO14	低	TXD0	SD6	DPI_D10	SPI5_MOSI	CTS5	TXD1
GPIO15	低	RXD0	SD7	DPI_D11	SPI5_SCLK	RTS5	RXD1
GPIO16	低	<保留>	SD8	DPI_D12	CTS0	SPI1_CE2_N	CTS1
GPIO17	低	<保留>	SD9	DPI_D13	RTS0	SPI1_CE1_N	RTS1
GPIO18	低	PCM_CLK	SD10	DPI_D14	SPI6_CE0_N	SPI1_CE0_N	PWM0_0
GPIO19	低	PCM_FS	SD11	DPI_D15	SPI6_MISO	SPI1_MISO	PWM0_1
GPIO20	低	PCM_DIN	SD12	DPI_D16	SPI6_MOSI	SPI1_MOSI	GPCLK0
GPIO21	低	PCM_DOUT	SD13	DPI_D17	SPI6_SCLK	SPI1_SCLK	GPCLK1
GPIO22	低	SD0_CLK	SD14	DPI_D18	SD1_CLK	ARM_TRST	SDA6
GPIO23	低	SD0_CMD	SD15	DPI_D19	SD1_CMD	ARM_RTCK	SCL6
GPIO24	低	SD0_DAT0	SD16	DPI_D20	SD1_DAT0	ARM_TDO	SPI3_CE1_N
GPIO25	低	SD0_DAT1	SD17	DPI_D21	SD1_DAT1	ARM_TCK	SPI4_CE1_N
GPIO26	低	SD0_DAT2	<保留>	DPI_D22	SD1_DAT2	ARM_TDI	SPI5_CE1_N
GPIO27	低	SD0_DAT3	<保留>	DPI_D23	SD1_DAT3	ARM_TMS	SPI6_CE1_N

GPIO	Pull	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
GPIO44	-	GPCLK1	SDA0	SDA1	<reserved>	SPI0_CE1_N	SD_CARD_VOLT
GPIO45	-	PWM0_1	SCL0	SCL1	<reserved>	SPI0_CE2_N	SD_CARD_PWR0

Special function legend:

Table 2. GPIO pins alternative function legend

Name	Function
SDA0	BSC master 0 data line[a]
SCL0	BSC master 0 clock line
SDAx	BSC master 1,3,4,5,6 data line[b]
SCLx	BSC master 1,3,4,5,6 clock line
GPCLKx	General purpose clock 0,1,2
SPIx_CE2_N	SPI 0,3,4,5,6 chip select 2
SPIx_CE1_N	SPI 0,3,4,5,6 chip select 1
SPIx_CE0_N	SPI 0,3,4,5,6 chip select 0
SPIx_MISO	SPI 0,3,4,5,6 MISO
SPIx_MOSI	SPI 0,3,4,5,6 MOSI
SPIx_SCLK	SPI 0,3,4,5,6 serial clock
PWMx_0	PWM 0,1 channel 0
PWMx_1	PWM 0,1 channel 1
TXDx	UART 0,2,3,4,5 transmit data
RXDx	UART 0,2,3,4,5 receive data
CTSx	UART 0,2,3,4,5 clear to send
RTSx	UART 0,2,3,4,5 request to send
PCM_CLK	PCM clock
PCM_FS	PCM frame sync
PCM_DIN	PCM data in
PCM_DOUT	PCM data out
SAx	Secondary mem address bus
SOE_N / SE	Secondary mem controls
SWE_N / SRW_N	Secondary mem controls
SDx	Secondary mem data bus
BSCSL SDA / MOSI	BSC slave data, SPI slave MOSI
BSCSL SCL / SCLK	BSC slave clock, SPI slave clock
BSCSL - / MISO	BSC <not used>, SPI MISO
BSCSL - / CE_N	BSC <not used>, SPI CSn
SPI1_CE2_N	SPI 1 chip select 2 [c]

GPIO	上下拉	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
GPIO44	-	GPCLK1	SDA0	SDA1	<保留>	SPI0_CE1_N	SD_CARD_VOLT
GPIO45	-	PWM0_1	SCL0	SCL1	<保留>	SPI0_CE2_N	SD_CARD_PWR0

特殊功能说明：

表2. GPIO引脚备用功能说明

名称	功能
SDA0	BSC 主控 0 数据线[a]
SCL0	BSC 主控 0 时钟线
SDAx	BSC 主控 1、3、4、5、6 数据线[b]
SCLx	BSC 主控 1、3、4、5、6 时钟线
GPCLKx	通用时钟 0、1、2
SPIx_CE2_N	SPI 0、3、4、5、6 片选 2
SPIx_CE1_N	SPI 0、3、4、5、6 片选 1
SPIx_CE0_N	SPI 0、3、4、5、6 片选 0
SPIx_MISO	SPI 0、3、4、5、6 MISO
SPIx_MOSI	SPI 0、3、4、5、6 MOSI
SPIx_SCLK	SPI 0、3、4、5、6 串行时钟
PWMx_0	PWM 0、1 通道 0
PWMx_1	PWM 0、1 通道 1
TXDx	UART 通用异步收发器 0、2、3、4、5 发送数据
RXDx	UART 通用异步收发器 0、2、3、4、5 接收数据
CTSx	UART 通用异步收发器 0、2、3、4、5 清除等待发送信号
RTSx	UART 通用异步收发器 0、2、3、4、5 请求发送信号
PCM_CLK	PCM 时钟
PCM_FS	PCM 帧同步
PCM_DIN	PCM 数据输入
PCM_DOUT	PCM 数据输出
SAx	二级存储器地址总线
SOE_N / SE	二级存储器控制信号
SWE_N / SRW_N	二级存储器控制信号
SDx	二级存储器数据总线
BSCSL SDA / MOSI	BSC 从属数据，SPI 从属 MOSI
BSCSL SCL / SCLK	BSC 从属时钟，SPI 从属时钟
BSCSL - / MISO	BSC <未使用>，SPI MISO
BSCSL - / CE_N	BSC <未使用>，SPI CSn
SPI1_CE2_N	SPI 1 芯片选择 2 [c]

Name	Function
SPI1_CE1_N	SPI 1 chip select 1
SPI1_CE0_N	SPI 1 chip select 0
SPI1_MISO	SPI 1 MISO
SPI1_MOSI	SPI 1 MOSI
SPI1_SCLK	SPI 1 serial clock
TXD1	UART 1 transmit data
RXD1	UART 1 receive data
CTS1	UART 1 clear to send
RTS1	UART 1 request To send
ARM_TRST	ARM JTAG reset
ARM_RTCK	ARM JTAG return clock
ARM_TDO	ARM JTAG data out
ARM_TCK	ARM JTAG clock
ARM_TDI	ARM JTAG data in
ARM_TMS	ARM JTAG mode select
PCLK	Display parallel interface
DE	Display parallel interface
LCD_VSYNC	Display parallel interface
LCD_HSYNC	Display parallel interface
DPI_Dx	Display parallel interface

[a] The Broadcom serial control bus is a proprietary bus compliant with the Philips® I2C bus/interface.
[b] BSC master 2 & 7 are not user-accessible.
[c] SPI 2 is not user-accessible.

2.6. Dual HDMI 2.0

The CM4 supports two HDMI 2.0 interfaces, each one capable of driving 4K images. If both HDMI outputs are used then each can be driven upto 4Kp30, however if only HDMI0 interface is being used then images up to 4Kp60 are possible.

HDMI signals should be routed as 100Ω differential pairs. Each signal within a pair should ideally be matched to better than 0.15mm. Pairs don't typically need any extra matching, as they only have to be matched to 25mm.

CEC is also supported; an internal 27kΩ pullup resistor is included in the CM4.

Basic on-board ESD protection is provided for the I2C EDID signals and the CEC signals; internal pullup and pulldown resistors are also provided. On the Raspberry Pi 4 Model B the HDMI signals don't have any extra ESD protection. Depending on the application, extra ESD protection may be required.

名称	功能
SPI1_CE1_N	SPI 1 芯片选择 1
SPI1_CE0_N	SPI 1 芯片选择 0
SPI1_MISO	SPI 1 MISO
SPI1_MOSI	SPI 1 MOSI
SPI1_SCLK	SPI 1 串行时钟
TXD1	UART 1 发送数据
RXD1	UART 1 接收数据
CTS1	UART 1 清除发送
RTS1	UART 1 请求发送
ARM_TRST	ARM JTAG 复位
ARM_RTCK	ARM JTAG 返回时钟
ARM_TDO	ARM JTAG 数据输出
ARM_TCK	ARM JTAG 时钟
ARM_TDI	ARM JTAG 数据输入
ARM_TMS	ARM JTAG 模式选择
PCLK	显示并行接口
DE	显示并行接口
LCD_VSYNC	显示并行接口
LCD_HSYNC	显示并行接口
DPI_Dx	显示并行接口

[a] Broadcom 串行控制总线是一种专有总线，符合 Philips® I2C 总线/接口标准。
[b] BSC 主机 2 和 7 不向用户开放访问。
[c] SPI 2 不向用户开放访问。

2.6. 双 HDMI 2.0

Compute Module 4 支持两个 HDMI 2.0 接口，每个接口均可驱动 4K 图像。如果同时使用两个 HDMI 输出，则每个接口最高支持 4Kp30；如果仅使用 HDMI0 接口，则图像最高可达 4Kp60。

HDMI 信号应采用 100Ω 差分对布线。每对信号中的单个信号理想状况下应匹配精度优于 0.15mm。差分对之间通常无需额外匹配，因为它们仅需匹配至 25mm。

CEC 也受到支持；CM4 内部包含一个 27kΩ 上拉电阻。

I2C EDID 信号和 CEC 信号提供了基本的板载 ESD 保护；同时也配备了内部上拉和下拉电阻。在 Raspberry Pi 4 型 B 上，HDMI 信号没有任何额外的 ESD 保护装置。
具体应用中可能需要额外的 ESD 保护。

2.7. CSI-2 (MIPI serial camera)

The CM4 supports two camera ports: `CAM0` (2 lanes) and `CAM1` (4 lanes). CSI signals should be routed as 100Ω differential pairs. Each signal within a pair should ideally be matched to better than 0.15mm.

The documentation around the CSI interface can be found on the Raspberry Pi website, while Linux kernel drivers can be found on GitHub.

NOTE

The official Raspberry Pi firmware supports the OmniVision OV5647, Sony IMX219, Sony IMX296, Sony IMX477 and Sony IMX708 camera sensors. No security device is required on Compute Module devices in order to use these camera sensors.

2.8. DSI (MIPI serial display)

The CM4 supports two display ports: `DISP0` (2 lanes) and `DISP1` (4 lanes). Each lane supports a maximum data rate per lane of 1Gbps.

Although Linux kernel drivers are available, the DSI interface is not currently documented. Only DSI displays supported by the official Raspberry Pi firmware are supported. DSI signals should be routed as 100Ω differential pairs; each signal within a pair should ideally be matched to better than 0.15mm.

NOTE

While only official DSI displays are supported, other displays can be added using the parallel DPI interface which is available as a GPIO alternative function. The CM4 supports up to three displays of any type (HDMI, DSI, DPI) at any one time.

2.9. I2C (SDA0 SCL0)

This internal I2C bus is normally allocated to the CSI1 and DSI1, as these devices are controlled by the firmware. It can be used as a general I2C bus if the CSI1 ad DSI1 interfaces aren't being used, or are being controlled by the firmware. For example libcamera runs on the ARM and doesn't use the firmware, so in this case you may use CSI1 and this I2C bus. SDA0 is connected to GPIO44 on the BCM2711 and SCL0 is connected to GPIO45.

2.10. I2C (ID_SD ID_SC)

This I2C bus is normally used for identifying HATs and controlling CSI0 and DSI0 devices. If the firmware isn't using the I2C bus e.g. CSI0 and DSI0 aren't being used then these pins may be used as GPIO 0 and GPIO 1 if required.

NOTE

If these pins are used as GPIO pins, then to prevent the firmware from checking to see if there is a HAT EEPROM available, add `force_eeprom_read=0` and `disable_poe_fan=1` to the config.txt file.

2.11. SDIO/eMMC (CM4Lite only)

The CM4Lite does not have on-board eMMC. The eMMC signals are available on the connector so that an external eMMC or SD card can be used.

2.7. CSI-2（MIPI 串行摄像头）

CM4 支持两个摄像头端口： `CAM0`(2 差分通道) 和 `CAM1`(4 差分通道)。 CSI 信号应以 100Ω 差分对布线。每个差分对中的信号理想情况下应匹配，误差不超过 0.15mm。

有关 CSI 接口的文档可在 Raspberry Pi 官网上查阅，Linux 内核驱动程序可在 GitHub 上获取。

注意

官方 Raspberry Pi 固件支持 OmniVision OV5647、Sony IMX219、Sony IMX296、Sony IMX477 和 Sony IMX708 摄像头传感器。在计算模块设备上使用这些摄像头传感器时，无需配备安全设备。

2.8. DSI（MIPI 串行显示器）

计算模块4支持两个显示端口： `DISP0`（2 路）和 `DISP1`（4 路）。 每一路的最大数据传输速率为1Gbps。

尽管提供了Linux内核驱动，但DSI接口当前尚无官方文档。仅支持官方Raspberry Pi固件兼容的DSI显示屏。DSI信号应以100Ω差分对方式布线；差分对内每个信号的长度应理想匹配，误差小于0.15mm。

注意

虽然仅支持官方DSI显示屏，但可通过作为GPIO替代功能的并行DPI接口接入其他显示屏。计算模块4最多支持同时连接三台任意类型的显示屏（HDMI、DSI、DPI）。

2.9. I2C (SDA0 SCL0)

该内部I2C总线通常分配给CSI1和DSI1，因这两个设备由固件控制。如果CSI1和DSI1接口未被使用或由固件控制，则该接口可作为通用I2C总线使用。
例如，libcamera运行于ARM上且不使用固件，因此在此情况下，您可以使用CSI1和该I2C总线。SDA0连接至BCM2711的GPIO44，SCL0连接至GPIO45。

2.10. I2C（ID_SD 与 ID_SC）

该I2C总线通常用于识别HAT以及控制CSI0和DSI0设备。如果固件未使用该I2C总线（例如CSI0和DSI0未被使用），则可根据需要将这些引脚用作GPIO0和GPIO1。

注意

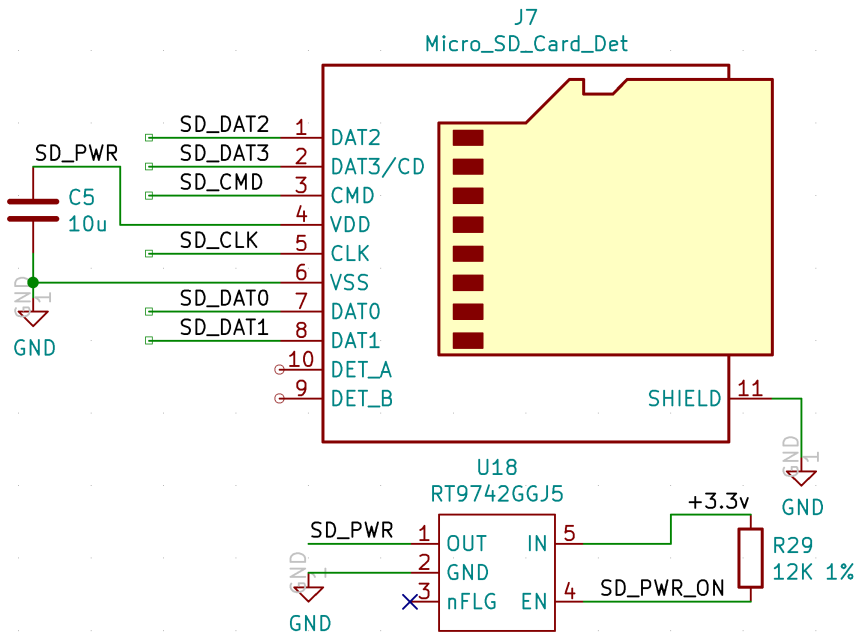
如果这些引脚用作GPIO，为防止固件检查是否存在HAT EEPROM，请在config.txt文件中添加`force_eeprom_read=0`和`disable_poe_fan=1`。

2.11. SDIO/eMMC（仅限 CM4Lite）

CM4Lite 不具备板载 eMMC。 eMMC 信号在连接器上可用，以支持外部 eMMC 或 SD 卡的连接。

The SD_PWR_ON signal is used to enable an external power-switch to turn on power to the SD card; for eMMC it typically isn't used. If booting from SD card is required, then a pullup resistor must also be fitted to default the power-switch to be on. When SD_VDD_OVERRIDE is high (3.3V), this forces 1.8V signalling on the SDIO interface. Typically this is used with eMMC memory.

Figure 3. CM4Lite SD card interface.



2.12. Analog IP0/IP1

These are the two spare inputs on the MXL7704. The MXL7704 datasheet should be consulted if these pins are to be used. On-board filtering is provided by a 100nF capacitor to ground for each signal. On the Raspberry Pi 4 Model B these are connected to the USB C connector CC1 and CC2 pins.

2.13. Global_EN

Pulling this pin low puts the CM4 in the lowest possible power-down state. After software shutdown, Global_EN needs to be pulled low for > 1ms to restart the power system on the CM4.

TIP

It is recommended to only pull this pin low once the OS has shut down.

2.14. RUN_PG

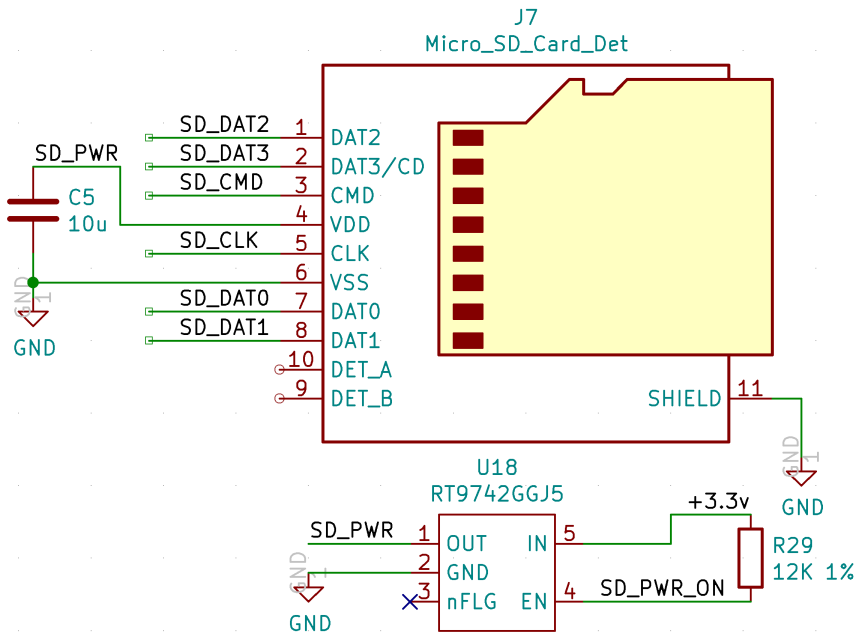
This pin when high signals that the CM4 has started. Driving this pin low resets the module. This should be done with caution; if files on a filesystem are open they will not be closed.

2.15. nRPI_BOOT

During boot if this pin is low, booting from eMMC will be stopped and booting will be transferred to rpi boot which is via USB.

信号 SD_PWR_ON用于启用外部电源开关以开启 SD 卡供电；而对于 eMMC 通常不使用此信号。如需从 SD 卡启动，则必须安装上拉电阻，使电源开关默认处于开启状态。当SD_VDD_OVERRIDE为高电平（3.3V）时，将强制 SDIO 接口使用 1.8V 信号。此功能通常用于 eMMC 存储器。

图 3。 CM4Lite SD 卡接口。



2.12. 模拟 IP0/IP1

这是 MXL7704 上的两个备用输入端口。如需使用此引脚，应查阅 MXL7704 数据手册。板载滤波通过每个信号接地的 100nF 电容实现。在 Raspberry Pi 4 型 B 上，这些电容连接至 USB C 连接器的 CC1和 CC2引脚。

2.13. Global_EN

将此引脚拉低可使 CM4 进入最低功耗的关断状态。软件关机后， Global_EN需拉低超过 1 毫秒，方可重新启动 CM4 的电源系统。

提示

建议仅在操作系统关闭后拉低此引脚。

2.14. RUN_PG

此引脚为高电平时表示 CM4 已启动。拉低此引脚将重置该模块。此操作应谨慎进行；如果文件系统中的文件处于打开状态，则不会关闭。

2.15. nRPI_BOOT

启动时，若此引脚为低电平，将停止从 eMMC 启动，启动流程将切换至通过 USB 的 rpi 启动。

2.16. LED_nACT

This pin is designed to drive an LED to replicate the green LED on the Raspberry Pi 4 Model B. Under Linux this pin will flash to signify eMMC access. If any error occurs during booting, then this LED will flash an error pattern which can be decoded using the look up table on the Raspberry Pi website.

2.17. LED_nPWR

This pin needs to be buffered to drive an LED. The signal is designed to replicate the red power LED on the Raspberry Pi 4 Model B.

2.18. EEPROM_nWP

It is recommended that final products pull this pin low to prevent the end users changing the contents of the on-board EEPROM. See the Raspberry Pi 4 Model B documentation for instructions on the software settings required to support EEPROM write protection.

2.16. LED_nACT

此引脚用于驱动 LED，以模拟 Raspberry Pi 4 型 B 上的绿色 LED。在 Linux 下，该引脚闪烁以表示 eMMC 访问。如果启动过程中出现任何错误，该 LED 灯将闪烁错误模式，可通过 Raspberry Pi 网站上的查找表进行解码。

2.17. LED_nPWR

该引脚需缓冲后驱动 LED。此信号设计用于模拟 Raspberry Pi 4 型 B 上的红色电源 LED。

2.18. EEPROM_nWP

建议最终产品将此引脚拉低，以防止终端用户更改板载 EEPROM 内容。有关支持 EEPROM 写保护的软件设置，请参见 Raspberry Pi 4 型 B 文档。

Chapter 3. Electrical and mechanical

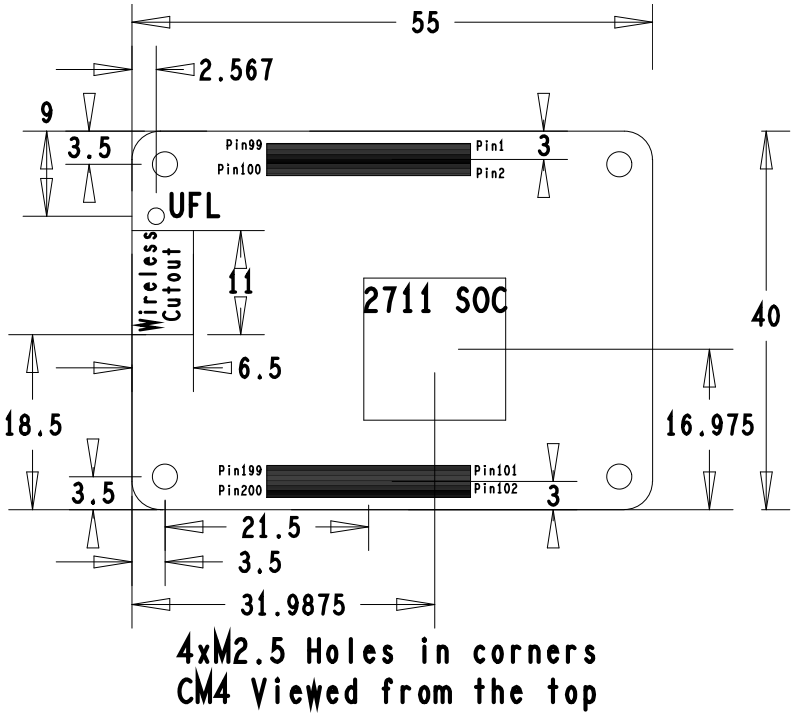
3.1. Mechanical

The CM4 is a compact 40mm × 55mm module. The Module is 4.7mm deep, but when connected the height will be 5.078mm or 6.578mm depending on the stacking height chosen.

1. 4 × M2.5 mounting holes (inset 3.5mm from module edge)
2. PCB thickness 1.2mm ± 10%
3. BCM2711 SoC height including solder balls 2.378 ± 0.11mm
4. Stacking height either:
    a. 1.5mm with mating connector (clearance under CM4 0mm): DF40C-100DS-0.4v
    b. 3.0mm with mating connector (clearance under CM4 1.5mm): DF40HC(3.0)-100DS-0.4v

If the on-board wireless antenna is used (see Section 2.1) it must be orientated towards the edge of the plastic enclosure and any nearby metal must have cut-outs or the wireless performance will be degraded. It is suggested that there is at least 10mm clearance around the PCB antenna, but the designer must check the performance.

Figure 4. Mechanical specification of the Raspberry Pi Compute Module 4



There must not be any metal, including ground planes, under the antenna. The ground plane cutout must be a minimum of 6.5mm × 11mm, but ideally at least 8mm × 15mm. If these requirements can't be met wireless performance may be degraded, especially in the 2.4GHz spectrum. It is recommended that the external antenna is used where possible.

章节 3. 电气与机械

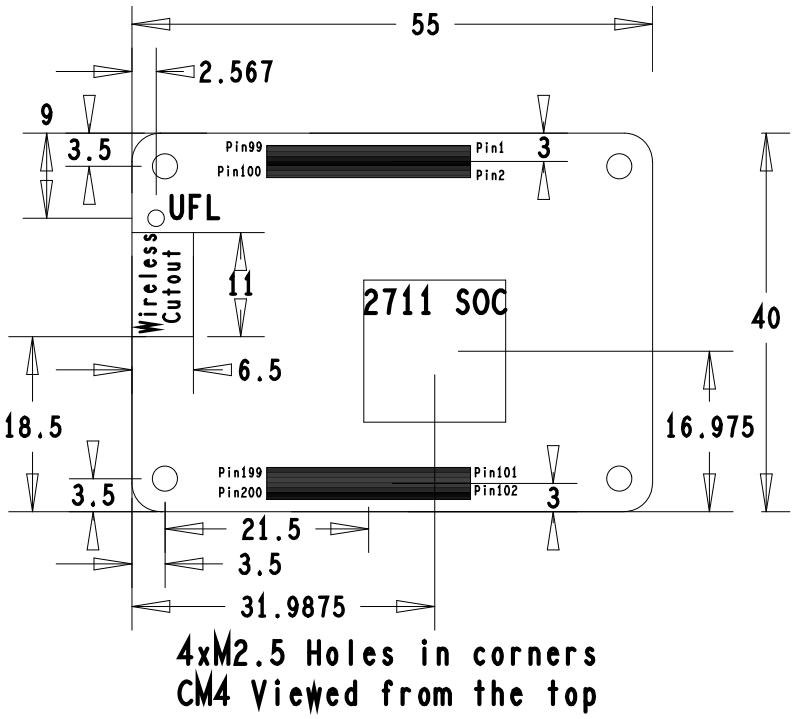
3.1. 机械

CM4 是一款尺寸为 40mm × 55mm 的紧凑型模块。该模块厚度为 4.7mm，连接后高度视选用的堆叠高度而定，为 5.078 mm 或 6.578mm。

1. 4 个 M2.5 安装孔（距模块边缘内凹 3.5mm）
2. PCB 厚度 1.2mm ± 10%
3. BCM2711 系统级芯片（SoC）含焊球高度 2.378 ± 0.11mm
4. 堆叠高度如下之一：
    a. 使用配套连接器时为 1.5mm（计算模块 4 下方间隙 0mm）：DF40C-100DS-0.4v
    b. 使用配套连接器时为 3.0mm（计算模块 4 下方间隙 1.5mm）：DF40HC(3.0)-100DS-0.4v

如果使用板载无线天线（见第 2.1 节），其方向必须朝向塑料外壳边缘，且任何邻近金属均须设有开口，否则无线性能将受到影响。建议 PCB 天线周围至少保持 10mm 的间隙，但设计者须自行验证性能。

图 4。 *Raspberry Pi 计算模块 4 机械规格*



天线下方不得存在任何金属，包括接地平面。接地平面开口的最小尺寸必须为6.5mm × 11mm，但理想尺寸应至少为8mm × 15mm。 若无法满足这些要求，无线性能可能会受损，尤其是在2.4GHz频段。建议尽可能使用外部天线。

NOTE

The location and arrangement of components on the Compute Module may change slightly over time due to revisions for cost and manufacturing considerations; however the maximum component heights and PCB thickness will be kept as specified.

A step file of the CM4 is available as part of the CM4 design data package. This is for guidance only and is subject to changes over time due to revisions.

3.2. Thermal

The CM4 dissipates less power than the Raspberry Pi 4 Model B. The CM4 also contains less metal in the PCB and fewer connectors, which means that it has less passive heat sinking than the Raspberry Pi 4 Model B. Despite it consuming less power, it may run warmer than the Raspberry Pi 4 Model B.

The BCM2711 will reduce the clock rate to try and keep its internal temperature below 85°C. So in high ambient temperatures it is possible that the clock will also be automatically throttled back. If the BCM2711 is unable to lower its internal clocks enough to bring the temperature down, its case temperature will rise above 85°C. It is important that any thermal solution chosen keeps the ambient temperature for the other silicon devices on the CM4 within the operating temperature range.

Operating temperature range: -20°C - +85°C non-condensing. NB Optimal RF wireless performance is between -20°C and +75°C.

3.3. Electrical specification

WARNING

Stresses above those listed in Table 3 may cause permanent damage to the device. This is a stress rating only; functional operation of the device under these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 3. Absolute maximum ratings

Symbol	Parameter	Minimum	Maximum	Unit
V_{IN}	5V Input Voltage	-0.5	6.0	V
V_{GPIO_VREF}	GPIO Voltage	-0.5	3.6	V
V_{gpio}	GPIO Input voltage	-0.5	V_{GPIO_VREF} + 0.5	V

NOTE

V_{GPIO_VREF} is the GPIO bank voltage, which must be tied to either the 3.3V or the 1.8V rail of the CM4.

Table 4. DC characteristics

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
$V_{IL(gpio)}$	Input low voltage	V_{GPIO_VREF} = 3.3V	0	-	0.8	V
$V_{IH(gpio)}$	Input high voltage	V_{GPIO_VREF} = 3.3V	2.0	-	V_{GPIO_VREF}	V

注意

由于成本和制造方面的修订，计算模块上的元件位置和排列可能会略有变化；但最大元件高度和PCB厚度将保持规定标准。

CM4的STEP文件作为CM4设计数据包的一部分提供。此信息仅供参考，且可能因修订而随时间发生变化。

3.2. 热管理

CM4的功耗低于Raspberry Pi 4 型 B。由于PCB中金属材料较少且连接器更少，CM4的被动散热效果不及Raspberry Pi 4 型 B。尽管功耗较低，CM4的运行温度可能高于Raspberry Pi 4 型 B。

BCM2711将降低时钟频率，以尝试将其内部温度控制在85°C以下。因此，在高环境温度时，时钟也可能会被自动降频。如果BCM2711无法将内部时钟降低至足够水平以降低温度，其外壳温度将超过85°C。 所选的任何散热解决方案必须确保CM4上其他硅基器件的环境温度保持在工作温度范围内，这一点至关重要。

工作温度范围：-20°C 至 +85°C，非冷凝条件。注意：最佳射频无线性能温度范围为-20°C至+75°C。

3.3. 电气规格

警告

表3中列出的应力超过该值可能导致器件永久损坏。这仅为应力等级；
不暗示器件在本规格书工作部分列出的任何其他条件以上的这些或其他条件下能够正常运行。长时间暴露于绝对最大额定条件下可能影响器件的可靠性。

表3. 绝对最大额定值

符号	参数	最小值	最大值	单位
V_{IN}	5V 输入电压	-0.5	6.0	伏特
V_{GPIO_VREF}	GPIO 电压	-0.5	3.6	伏特
V_{gpio}	GPIO 输入电压	-0.5	V_{GPIO_VREF} + 0.5	伏特

注意

V_{GPIO_VREF} 是 $_{GPIO}$ 电压域，必须连接至 CM4 的 3.3V 或 1.8V 电源轨。

表 4. 直流特性

符号	参数	条件	最小值	典型值	最大值	单位
$V_{IL(gpio)}$	输入低电压	V_{GPIO_VREF} = 3.3V	0	-	0.8	伏特
$V_{IH(gpio)}$	输入高电压	V_{GPIO_VREF} = 3.3V	2.0	-	V_{GPIO_VREF}	伏特

$V_{IL(gpio)}$	Input low voltage	V_{GPIO_VREF} = 1.8V	0	-	0.35	V
$V_{IH(gpio)}$	Input high voltage	V_{GPIO_VREF} = 1.8V	0.65	-	V_{GPIO_VREF}	V
$I_{IL(gpio)}$	Input leakage current	-	-	-	10	µA
$V_{OL(gpio)}$	Output low voltage	-	-	-	0.4	V
$V_{OH(gpio)}$	Output high voltage	-	V_{GPIO_VREF} - 0.4	-	-	V
$I_{O(gpio)}$	Output current	1mA	0.87	1.3	-	mA
$I_{O(gpio)}$	Output current	2mA	1.75	2.6	-	mA
$I_{O(gpio)}$	Output current	3mA	2.63	3.9	-	mA
$I_{O(gpio)}$	Output current	4mA **default**	3.5	5.3	-	mA
$I_{O(gpio)}$	Output current	5mA	4.39	6.6	-	mA
$I_{O(gpio)}$	Output current	6mA	5.27	7.9	-	mA
$I_{O(gpio)}$	Output current	7mA	6.15	9.2	-	mA
$I_{O(gpio)}$	Output current	8mA	7.02	10.5	-	mA
$R_{PU(gpio)}$	Pullup resistor	V_{GPIO_VREF} = 3.3V	33	47	73	kΩ
$R_{PD(gpio)}$	Pulldown resistor	V_{GPIO_VREF} = 3.3V	33	47	73	kΩ
$R_{PU(gpio)}$	Pullup resistor	V_{GPIO_VREF} = 1.8V	18	47	73	kΩ
$R_{PD(gpio)}$	Pulldown resistor	V_{GPIO_VREF} = 1.8V	18	47	73	kΩ

Refer to interface specifications (see Chapter 2) for electrical details of other interfaces.

Table 5. Power consumption

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
$I_{shutdown}$	Shutdown current	`GLOBAL_EN` = 0V	-	15	-	µA
$I_{shutdown}$	Shutdown current	`GLOBAL_EN` > 2V	-	8	-	mA
I_{idle}	Idle current	`GLOBAL_EN` > 2V	-	400	-	mA
I_{load}	Operation current	`GLOBAL_EN` > 2V	-	1400	-	mA

NOTE

The figures in Table 5 greatly depend on the end application.

$V_{IL(gpio)}$	输入低电压	V_{GPIO_VREF} = 1.8V	0	-	0.35	伏特
$V_{IH(gpio)}$	输入高电压	V_{GPIO_VREF} = 1.8V	0.65	-	V_{GPIO_VREF}	伏特
$I_{IL(gpio)}$	输入漏电流	-	-	-	10	μA
$V_{OL(gpio)}$	输出低电压	-	-	-	0.4	伏特
$V_{OH(gpio)}$	输出高电压	-	V_{GPIO_VREF} - 0.4	-	-	伏特
$I_{O(gpio)}$	输出电流	1mA	0.87	1.3	-	mA
$I_{O(gpio)}$	输出电流	2mA	1.75	2.6	-	mA
$I_{O(gpio)}$	输出电流	3mA	2.63	3.9	-	mA
$I_{O(gpio)}$	输出电流	4mA **默认**	3.5	5.3	-	mA
$I_{O(gpio)}$	输出电流	5mA	4.39	6.6	-	mA
$I_{O(gpio)}$	输出电流	6mA	5.27	7.9	-	mA
$I_{O(gpio)}$	输出电流	7mA	6.15	9.2	-	mA
$I_{O(gpio)}$	输出电流	8mA	7.02	10.5	-	mA
$R_{PU(gpio)}$	上拉电阻	V_{GPIO_VREF} = 3.3V	33	47	73	kΩ
$R_{PD(gpio)}$	下拉电阻	V_{GPIO_VREF} = 3.3V	33	47	73	kΩ
$R_{PU(gpio)}$	上拉电阻	V_{GPIO_VREF} = 1.8V	18	47	73	kΩ
$R_{PD(gpio)}$	下拉电阻	V_{GPIO_VREF} = 1.8V	18	47	73	kΩ

有关其他接口的电气细节，请参阅接口规范（见第2章）。

表 5. 功耗

符号	参数	条件	最小值	典型值	最大值	单位
$I_{关机}$	关机电流	GLOBAL_EN = 0V	-	15	-	μA
$I_{关机}$	关机电流	GLOBAL_EN > 2V	-	8	-	mA
$I_{空闲}$	空载电流	GLOBAL_EN > 2V	-	400	-	mA
电流负载	工作电流	GLOBAL_EN > 2V	-	1400	-	mA

注意

表5中的数值高度依赖于最终应用。

Chapter 4. Pinout

Table 6. Pinout for the Raspberry Pi Compute Module 4

Pin	Signal	Description
1	GND	Ground (0V)
2	GND	Ground (0V)
3	Ethernet_Pair3_P	Ethernet pair 3 positive (connect to transformer or MagJack)
4	Ethernet_Pair1_P	Ethernet pair 1 positive (connect to transformer or MagJack)
5	Ethernet_Pair3_N	Ethernet pair 3 negative (connect to transformer or MagJack)
6	Ethernet_Pair1_N	Ethernet pair 1 negative (connect to transformer or MagJack)
7	GND	Ground (0V)
8	GND	Ground (0V)
9	Ethernet_Pair2_N	Ethernet pair 2 negative (connect to transformer or MagJack)
10	Ethernet_Pair0_N	Ethernet pair 0 negative (connect to transformer or MagJack)
11	Ethernet_Pair2_P	Ethernet pair 2 positive (connect to transformer or MagJack)
12	Ethernet_Pair0_P	Ethernet pair 0 positive (connect to transformer or MagJack)
13	GND	Ground (0V)
14	GND	Ground (0V)
15	Ethernet_nLED3	Active-low Ethernet activity indicator (`CM4_3.3V` signal): typically a green LED is connected to this pin. I_{OL} = 8mA @ V_{OL} < 0.4V
16	Ethernet_SYNC_IN	IEEE1588 SYNC Input pin (`CM4_3.3V` signal: I_{OL} = 8mA @ V_{OL} < 0.4V)
17	Ethernet_nLED2	Active-low Ethernet speed indicator (`CM4_3.3V`signal): typically a yellow LED is connected to this pin. A low state indicates the 1Gbit or 100Mbit link: I_{OL} = 8mA @ V_{OL} < 0.4V
18	Ethernet_SYNC_OUT	IEEE1588 SYNC Output pin (`CM4_3.3V` signal: I_{OL} = 8mA @ V_{OL} < 0.4V)
19	Ethernet_nLED1	Active-low Ethernet speed indicator (`CM4_3.3V` signal): typically a yellow LED is connected to this pin. A low state indicates the 1Gbit or 10Mbit link: I_{OL} = 8mA @ V_{OL} < 0.4V
20	EEPROM_nWP	Leave floating NB internally pulled up to `CM4_3.3V` via 100kΩ (V_{IL} < 0.8V), but can be grounded to prevent writing to the on-board EEPROM which stores the bootcode
21	Pi_nLED_Activity	Active-low Pi activity LED. 20mA Max, 5V tolerant (V_{OL} < 0.4V). (this is the signal that drives the green LED on the Raspberry Pi 4 Model B)
22	GND	Ground (0V)
23	GND	Ground (0V)
24	GPIO26	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to `CM4_1.8V`
25	GPIO21	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to `CM4_1.8V`
26	GPIO19	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to `CM4_1.8V`
27	GPIO20	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to `CM4_1.8V`

第4章节 引脚定义

表6. *Raspberry Pi* 计算模块*4* 引脚定义

引脚	信号	说明
1	GND	接地（0V）
2	GND	接地（0V）
3	Ethernet_Pair3_P	以太网对3正极（连接至变压器或MagJack）
4	Ethernet_Pair1_P	以太网对1正极（连接至变压器或MagJack）
5	Ethernet_Pair3_N	以太网对3负极（连接至变压器或MagJack）
6	Ethernet_Pair1_N	以太网对1负极（连接至变压器或MagJack）
7	GND	接地（0V）
8	GND	接地（0V）
9	Ethernet_Pair2_N	以太网对2负极（连接至变压器或MagJack）
10	Ethernet_Pair0_N	以太网对0负极（连接至变压器或MagJack）
11	Ethernet_Pair2_P	以太网对2正极（连接至变压器或MagJack）
12	Ethernet_Pair0_P	以太网对0正极（连接至变压器或MagJack）
13	GND	接地（0V）
14	GND	接地（0V）
15	Ethernet_nLED3	低电平以太网活动指示器（CM4_3.3V信号）：通常连接一个绿色LED至此引脚。I_{OL}= 8mA，V_{OL}< 0.4V
16	Ethernet_SYNC_IN	IEEE1588 同步输入引脚（ CM4_3.3V 信号：I_{OL} = 8mA，V_{OL} < 0.4V)
17	Ethernet_nLED2	低电平以太网速度指示器（`CM4_3.3V`信号）：通常连接一个黄色LED至此引脚。低电平表示1Gbit或100Mbit链路：I_{OL}= 8mA，V_{OL} < 0.4V
18	Ethernet_SYNC_OUT	IEEE1588 同步输出引脚（ CM4_3.3V 信号：I_{OL} = 8mA，V_{OL} < 0.4V)
19	Ethernet_nLED1	低电平以太网速率指示器（CM4_3.3V信号）：通常在此引脚连接一黄色LED。低电平表示1 Gbit或10Mbit链路：I_{OL}= 8mA，V_{OL}< 0.4V
20	EEPROM_nWP	保持悬空，注意内部通过100kΩ上拉至 CM4_3.3V（V_{IL}< 0.8V），但可接地以防止写入存储启动代码的板载EEPROM
21	Pi_nLED_Activity	低电平Pi活动指示灯。最大20mA，5V兼容（V_{OL}< 0.4V）。（此信号驱动Raspberry Pi 4型B上的绿色LED）
22	GND	接地（0V）
23	GND	接地（0V）
24	GPIO26	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
25	GPIO21	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
26	GPIO19	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
27	GPIO20	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V

28	GPIO13	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
29	GPIO16	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
30	GPIO6	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
31	GPIO12	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
32	GND	Ground (0V)
33	GND	Ground (0V)
34	GPIO5	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
35	ID_SC	(BCM2711 GPIO 1) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
36	ID_SD	(BCM2711 GPIO 0) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
37	GPIO7	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
38	GPIO11	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
39	GPIO8	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
40	GPIO9	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
41	GPIO25	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
42	GND	Ground (0V)
43	GND	Ground (0V)
44	GPIO10	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
45	GPIO24	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
46	GPIO22	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
47	GPIO23	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
48	GPIO27	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
49	GPIO18	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
50	GPIO17	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
51	GPIO15	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
52	GND	Ground (0V)

28	GPIO13	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
29	GPIO16	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
30	GPIO6	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
31	GPIO12	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
32	GND	接地（0V）
33	GND	接地（0V）
34	GPIO5	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
35	ID_SC	(BCM2711 GPIO 1) GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V切换为1.8V信号
36	ID_SD	(BCM2711 GPIO 0) GPIO：通常为3.3V信号，但通过将GPIO_VREF连接至 CM4_1.8V可配置为1.8V信号
37	GPIO7	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
38	GPIO11	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
39	GPIO8	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
40	GPIO9	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
41	GPIO25	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
42	GND	接地（0V）
43	GND	接地（0V）
44	GPIO10	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
45	GPIO24	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
46	GPIO22	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
47	GPIO23	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
48	GPIO27	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
49	GPIO18	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
50	GPIO17	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
51	GPIO15	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
52	GND	接地（0V）

53	GND	Ground (0V)
54	GPIO4	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
55	GPIO14	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V
56	GPIO3	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V. Internal 1.8kΩ pull up to GPIO_VREF
57	SD_CLK	SD card clock signal (only available on CM4Lite)
58	GPIO2	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to CM4_1.8V. Internal 1.8kΩ pull up to GPIO_VREF
59	GND	Ground (0V)
60	GND	Ground (0V)
61	SD_DAT3	SD card/eMMC Data3 signal (only available on CM4Lite)
62	SD_CMD	SD card/eMMC Command signal (only available on CM4Lite)
63	SD_DAT0	SD card/eMMC Data0 signal (only available on CM4Lite)
64	SD_DAT5	SD card/eMMC Data5 signal (only available on CM4Lite)
65	GND	Ground (0V)
66	GND	Ground (0V)
67	SD_DAT1	SD card/eMMC Data1 signal (only available on CM4Lite)
68	SD_DAT4	SD card/eMMC Data4 signal (only available on CM4Lite)
69	SD_DAT2	SD card/eMMC Data2 signal (only available on CM4Lite)
70	SD_DAT7	SD card/eMMC Data7 signal (only available on CM4Lite)
71	GND	Ground (0V)
72	SD_DAT6	SD card/eMMC Data6 signal (only available on CM4Lite)
73	SD_VDD_OVERRIDE	Connect to CM4_3.3V to force SD card/eMMC interface to 1.8V signalling instead of 3.3V, otherwise leave unconnected. Typically only used if external eMMC is connected.
74	GND	Ground (0V)
75	SD_PWR_ON	Output to power-switch for the SD card. The CM4 sets this pin high (3.3V) to signal that power to the SD card should be turned on. If booting from the SD card is required then a pullup should also be fitted so the power-switch defaults to on. (only available on CM4Lite)
76	Reserved	Do not connect anything to this pin.
77	+5V (Input)	4.75V-5.25V. Main power input
78	GPIO_VREF	Must be connected to CM4_3.3V (pins 84 and 86) for 3.3V GPIO or CM4_1.8V (pins 88 and 90) for 1.8V GPIO. This pin cannot be floating or connected to ground.
79	+5V (Input)	4.75V-5.25V. Main power input
80	SCL0	I2C clock pin (BCM2711 GPIO45): typically used for Camera and Display. Internal 1.8kΩ pull up to CM4_3.3V
81	+5V (Input)	4.75V-5.25V. Main power input
82	SDA0	I2C Data pin (BCM2711 GPIO44): typically used for Camera and Display. Internal 1.8kΩ pull up to CM4_3.3V

53	GND	接地（0V）
54	GPIO4	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
55	GPIO14	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V
56	GPIO3	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V。 内部1.8kΩ上拉至GPIO_VREF
57	SD_CLK	SD 卡时钟信号（仅适用于CM4Lite）
58	GPIO2	GPIO：通常为3.3V信号，但可通过将GPIO_VREF连接至 CM4_1.8V。 内部1.8kΩ上拉至GPIO_VREF
59	GND	接地（0V）
60	GND	接地（0V）
61	SD_DAT3	SD 卡/eMMC Data3信号（仅适用于CM4Lite）
62	SD_CMD	SD 卡/eMMC 命令信号（仅适用于CM4Lite）
63	SD_DAT0	SD 卡/eMMC Data0信号（仅适用于CM4Lite）
64	SD_DAT5	SD 卡/eMMC Data5信号（仅适用于CM4Lite）
65	GND	接地（0V）
66	GND	接地（0V）
67	SD_DAT1	SD 卡/eMMC Data1信号（仅适用于CM4Lite）
68	SD_DAT4	SD 卡/eMMC Data4信号（仅适用于CM4Lite）
69	SD_DAT2	SD 卡/eMMC Data2信号（仅适用于CM4Lite）
70	SD_DAT7	SD 卡/eMMC Data7信号（仅适用于CM4Lite）
71	GND	接地（0V）
72	SD_DAT6	SD 卡/eMMC Data6 信号（仅适用于 CM4Lite）
73	SD_VDD_OVERRIDE	连接至 CM4_3.3V以强制 SD 卡/eMMC 接口使用 1.8V 信号而非 3.3V，否则保持未连接。通常仅在外接 eMMC 时使用。
74	GND	接地（0V）
75	SD_PWR_ON	输出至 SD 卡电源开关。CM4 将该引脚拉高（3.3V），以表示应开启 SD 卡电源。如需从 SD 卡启动，则应同时连接上拉电阻，使电源开关默认开启。（仅适用于 CM4Lite）
76	保留	禁止连接任何信号至此引脚。
77	+5V（输入）	4.75V–5.25V，主电源输入
78	GPIO_VREF	必须连接至 CM4_3.3V（引脚 84 和 86）用于 3.3V GPIO，或 CM4_1.8V（引脚 88 和 90）用于 1.8V GPIO。该引脚不得悬空或接地。
79	+5V（输入）	4.75V–5.25V，主电源输入
80	SCL0	I2C时钟引脚（BCM2711 GPIO45）：通常用于摄像头和显示器。内部通过1.8kΩ上拉至 CM4_3.3V
81	+5V（输入）	4.75V–5.25V，主电源输入
82	SDA0	I2C数据引脚（BCM2711 GPIO44）：通常用于摄像头和显示器。内部通过1.8kΩ上拉至 CM4_3.3V

83	+5V (Input)	4.75V-5.25V. Main power input
84	CM4_3.3V (Output)	3.3V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
85	+5V (Input)	4.75V-5.25V. Main power input
86	CM4_3.3V (Output)	3.3V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
87	+5V (Input)	4.75V-5.25V. Main power input
88	CM4_1.8V (Output)	1.8V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
89	WL_nDisable	Can be left floating; if driven low the wireless interface will be disabled. Internally pulled up via 1.8kΩ to `CM4_3.3V`
90	CM4_1.8V (Output)	1.8V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
91	BT_nDisable	Can be left floating; if driven low the Bluetooth interface will be disabled. Internally pulled up via 1.8kΩ to `CM4_3.3V`
92	RUN_PG	Bidirectional pin. Can be driven low (via a 220Ω resistor) to reset the CM4 CPU. As an output, a high signals that power is good and CPU is running. Internally pulled up to +3.3V via 10kΩ
93	nRPIBOOT	A low on this pin forces booting from an RPI server (e.g. PC or a Raspberry Pi); if not used leave floating. Internally pulled up via 10kΩ to +3.3V
94	AnalogIP1	Analogue input of the MXL7704: typically connected to CC pin of Type C power connector
95	PI_LED_nPWR	Active-low output to drive Power On LED. This signal needs to be buffered.
96	AnalogIP0	Analogue input of the MXL7704: typically connected to CC pin of Type C power connector
97	Camera_GPIO	Typically used to shut down the camera to reduce power. Reassigning this pin to another function isn't recommended. `CM4_3.3V` signalling
98	GND	Ground (0V)
99	GLOBAL_EN	Input. Drive low to power off CM4. Internally pulled up with a 100kΩ to +5V
100	nEXTRST	Output. Driven low during reset; Driven high (`CM4_3.3V`) once CM4 CPU has started to boot
101	USB_OTG_ID	Input (3.3V signal) USB OTG Pin. Internally pulled up. When grounded the CM4 becomes a USB host but the correct OS driver also needs to be used
102	PCIe_CLK_nREQ	Input (3.3V signal) PCIe clock request pin (low to request PCI clock). Internally pulled up
103	USB_N	USB D-
104	Reserved	Do not connect anything to this pin.
105	USB_P	USB D+
106	Reserved	Do not connect anything to this pin.
107	GND	Ground (0V)
108	GND	Ground (0V)
109	PCIe_nRST	Output (+3.3V signal) PCIe reset active-low
110	PCIe_CLK_P	PCIe clock Out positive (100MHz) NB AC coupling capacitor included on CM4
111	VDAC_COMP	Video DAC output (TV OUT)

83	+5V（输入）	4.75V–5.25V，主电源输入
84	CM4_3.3V（输出）	3.3V ± 2.5%。每引脚最大输出电流为300mA，总计不超过600mA。 在断电或GLOBAL_EN被置低时，此电源将关闭。
85	+5V（输入）	4.75V–5.25V，主电源输入
86	CM4_3.3V（输出）	3.3V ± 2.5%。每引脚最大输出电流为300mA，总计不超过600mA。 在断电或GLOBAL_EN被置低时，此电源将关闭。
87	+5V（输入）	4.75V–5.25V，主电源输入
88	CM4_1.8V（输出）	1.8V ± 2.5%。每引脚最大输出电流为300mA，总计不超过600mA。 在断电或GLOBAL_EN被置低时，此电源将关闭。
89	WL_nDisable	可悬空；若被拉低，无线接口将被禁用。内部通过1.8kΩ电阻上拉至 CM4_3.3V
90	CM4_1.8V（输出）	1.8V ± 2.5%。每引脚最大输出电流为300mA，总计不超过600mA。 在断电或GLOBAL_EN被置低时，此电源将关闭。
91	BT_nDisable	可悬空；若该引脚被拉低，蓝牙接口将被禁用。内部通过1.8kΩ电阻上拉至 CM4_3.3V
92	RUN_PG	双向引脚。可通过220Ω电阻拉低以复位CM4 CPU。作为输出时，高电平表示电源正常且CPU正在运行。内部通过10kΩ电阻上拉至+3.3V
93	nRPIBOOT	该引脚拉低时，强制从RPI服务器（如PC或Raspberry Pi）启动；若不使用，请保持悬空。内部通过10kΩ电阻上拉至+3.3V
94	AnalogIP1	MXL7704的模拟输入：通常连接至Type-C电源连接器的CC引脚
95	PI_LED_nPWR	低电平有效输出，用于驱动电源指示灯（Power On LED）。此信号需经过缓冲。
96	AnalogIP0	MXL7704的模拟输入：通常连接至Type-C电源连接器的CC引脚
97	Camera_GPIO	通常用于关闭摄像头以降低功耗。不建议将此引脚重新分配至其他功能。 CM4_3.3V信号
98	GND	接地（0V）
99	GLOBAL_EN	输入。拉低以关闭 CM4 电源。内部以 100kΩ 电阻上拉至 +5V
100	nEXTRST	输出。复位期间被拉低；CM4 CPU 启动引导后被拉高（CM4_3.3V）
101	USB_OTG_ID	输入（3.3V 信号）USB OTG 引脚。内部上拉。接地时 CM4 转为 USB 主机，但需使用正确的操作系统驱动
102	PCIe_CLK_nREQ	输入（3.3V 信号）PCIe 时钟请求引脚（低电平请求 PCI 时钟）。内部上拉
103	USB_N	USB D-
104	保留	禁止连接任何信号至此引脚。
105	USB_P	USB D+
106	保留	禁止连接任何信号至此引脚。
107	GND	接地（0V）
108	GND	接地（0V）
109	PCIe_nRST	输出（+3.3V 信号）PCIe 复位，有效低电平
110	PCIe_CLK_P	PCIe 时钟输出正极（100MHz），CM4 内置交流耦合电容
111	VDAC_COMP	视频 DAC 输出（电视输出）

112	PCIe_CLK_N	PCIe clock Out negative (100MHz) NB AC coupling capacitor included on CM4
113	GND	Ground (0V)
114	GND	Ground (0V)
115	CAM1_D0_N	Input Camera1 D0 negative
116	PCIe_RX_P	Input PCIe GEN 2 RX positive NB external AC coupling capacitor required
117	CAM1_D0_P	Input Camera1 D0 positive
118	PCIe_RX_N	Input PCIe GEN 2 RX negative NB external AC coupling capacitor required
119	GND	Ground (0V)
120	GND	Ground (0V)
121	CAM1_D1_N	Input Camera1 D1 negative
122	PCIe_TX_P	Output PCIe GEN 2 TX positive NB AC coupling capacitor included on CM4
123	CAM1_D1_P	Input Camera1 D1 positive
124	PCIe_TX_N	Output PCIe GEN 2 TX positive NB AC coupling capacitor included on CM4
125	GND	Ground (0V)
126	GND	Ground (0V)
127	CAM1_C_N	Input Camera1 clock negative
128	CAM0_D0_N	Input Camera0 D0 negative
129	CAM1_C_P	Input Camera1 clock positive
130	CAM0_D0_P	Input Camera0 D0 positive
131	GND	Ground (0V)
132	GND	Ground (0V)
133	CAM1_D2_N	Input Camera1 D2 negative
134	CAM0_D1_N	Input Camera0 D1 negative
135	CAM1_D2_P	Input Camera1 D2 positive
136	CAM0_D1_P	Input Camera0 D1 positive
137	GND	Ground (0V)
138	GND	Ground (0V)
139	CAM1_D3_N	Input Camera1 D3 negative
140	CAM0_C_N	Input Camera0 clock negative
141	CAM1_D3_P	Input Camera1 D3 positive
142	CAM0_C_P	Input Camera0 clock positive
143	HDMI1_HOTPLUG	Input HDMI1 hotplug. Internally pulled down with a 100kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)
144	GND	Ground (0V)
145	HDMI1_SDA	Bidirectional HDMI1 SDA. Internally pulled up with a 1.8kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)

112	PCIe_CLK_N	PCIe 时钟输出负极（100MHz），CM4 内置交流耦合电容
113	GND	接地（0V）
114	GND	接地（0V）
115	CAM1_D0_N	输入 Camera1 D0 负极
116	PCIe_RX_P	输入 PCIe GEN 2 RX 正极，须外接交流耦合电容
117	CAM1_D0_P	输入 Camera1 D0 正极
118	PCIe_RX_N	输入 PCIe GEN 2 RX 负极，NB 需外部交流耦合电容
119	GND	接地（0V）
120	GND	接地（0V）
121	CAM1_D1_N	输入 Camera1 D1 负极
122	PCIe_TX_P	输出 PCIe GEN 2 TX 正极，NB CM4 内置交流耦合电容
123	CAM1_D1_P	输入 Camera1 D1 正极
124	PCIe_TX_N	输出 PCIe GEN 2 TX 正极，NB CM4 内置交流耦合电容
125	GND	接地（0V）
126	GND	接地（0V）
127	CAM1_C_N	输入 Camera1 时钟负极
128	CAM0_D0_N	输入 Camera0 D0 负极
129	CAM1_C_P	输入 Camera1 时钟正极
130	CAM0_D0_P	输入 Camera0 D0 正极
131	GND	接地（0V）
132	GND	接地（0V）
133	CAM1_D2_N	输入 Camera1 D2 负极
134	CAM0_D1_N	输入 Camera0 D1 负极
135	CAM1_D2_P	输入 Camera1 D2 正极
136	CAM0_D1_P	输入 Camera0 D1 正极
137	GND	接地（0V）
138	GND	接地（0V）
139	CAM1_D3_N	输入 Camera1 D3 负极
140	CAM0_C_N	输入 Camera0 时钟负极
141	CAM1_D3_P	输入 Camera1 D3 正极
142	CAM0_C_P	输入 Camera0 时钟正极
143	HDMI1_HOTPLUG	输入 HDMI1 热插拔信号内部通过100kΩ下拉电阻。5V兼容。（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）
144	GND	接地（0V）
145	HDMI1_SDA	双向HDMI1 SDA。内部通过1.8kΩ上拉电阻。5V兼容。（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）

146	HDMI1_TX2_P	Output HDMI1 TX2 positive
147	HDMI1_SCL	Bidirectional HDMI1 SCL. Internally pulled up with a 1.8kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)
148	HDMI1_TX2_N	Output HDMI1 TX2 negative
149	HDMI1_CEC	Input HDMI1 CEC. Internally pulled up with a 27kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)
150	GND	Ground (0V)
151	HDMI0_CEC	Input HDMI0 CEC. Internally pulled up with a 27kΩ. 5V tolerant (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)
152	HDMI1_TX1_P	Output HDMI1 TX1 positive
153	HDMI0_HOTPLUG	Input HDMI0 hotplug. Internally pulled down 100kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)
154	HDMI1_TX1_N	Output HDMI1 TX1 negative
155	GND	Ground (0V)
156	GND	Ground (0V)
157	DSI0_D0_N	Output Display0 D0 negative
158	HDMI1_TX0_P	Output HDMI1 TX0 positive
159	DSI0_D0_P	Output Display0 D0 positive
160	HDMI1_TX0_N	Output HDMI1 TX0 negative
161	GND	Ground (0V)
162	GND	Ground (0V)
163	DSI0_D1_N	Output Display0 D1 negative
164	HDMI1_CLK_P	Output HDMI1 clock positive
165	DSI0_D1_P	Output Display0 D1 positive
166	HDMI1_CLK_N	Output HDMI1 clock negative
167	GND	Ground (0V)
168	GND	Ground (0V)
169	DSI0_C_N	Output Display0 clock negative
170	HDMI0_TX2_P	Output HDMI0 TX2 positive
171	DSI0_C_P	Output Display0 clock positive
172	HDMI0_TX2_N	Output HDMI0 TX2 negative
173	GND	Ground (0V)
174	GND	Ground (0V)
175	DSI1_D0_N	Output Display1 D0 negative
176	HDMI0_TX1_P	Output HDMI0 TX1 positive

146	HDMI1_TX2_P	输出HDMI1 TX2正极
147	HDMI1_SCL	双向HDMI1 SCL。内部通过1.8kΩ上拉电阻。5V兼容。（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）
148	HDMI1_TX2_N	输出HDMI1 TX2负极
149	HDMI1_CEC	输入HDMI1 CEC。内部通过27kΩ上拉电阻。5V兼容。（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）
150	GND	接地（0V）
151	HDMI0_CEC	输入HDMI0 CEC。内部通过27kΩ上拉电阻。5V兼容（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）
152	HDMI1_TX1_P	输出 HDMI1 TX1 正极
153	HDMI0_HOTPLUG	输入 HDMI0 热插拔内部下拉 100kΩ，5V 兼容（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）
154	HDMI1_TX1_N	输出 HDMI1 TX1 负极
155	GND	接地（0V）
156	GND	接地（0V）
157	DSI0_D0_N	输出 Display0 D0 负极
158	HDMI1_TX0_P	输出 HDMI1 TX0 正极
159	DSI0_D0_P	输出 Display0 D0 正极
160	HDMI1_TX0_N	输出 HDMI1 TX0 负极
161	GND	接地（0V）
162	GND	接地（0V）
163	DSI0_D1_N	输出 Display0 D1 负极
164	HDMI1_CLK_P	输出 HDMI1 时钟正极
165	DSI0_D1_P	输出 Display0 D1 正极
166	HDMI1_CLK_N	输出 HDMI1 时钟负极
167	GND	接地（0V）
168	GND	接地（0V）
169	DSI0_C_N	输出 Display0 时钟负极
170	HDMI0_TX2_P	输出 HDMI0 TX2 正极
171	DSI0_C_P	输出 Display0 时钟正极
172	HDMI0_TX2_N	输出 HDMI0 TX2 负极
173	GND	接地（0V）
174	GND	接地（0V）
175	DSI1_D0_N	输出 Display1 D0 负极
176	HDMI0_TX1_P	输出 HDMI0 TX1 正极

177	DSI1_D0_P	Output Display1 D0 positive
178	HDMI0_TX1_N	Output HDMI0 TX1 negative
179	GND	Ground (0V)
180	GND	Ground (0V)
181	DSI1_D1_N	Output Display1 D1 negative
182	HDMI0_TX0_P	Output HDMI0 TX0 positive
183	DSI1_D1_P	Output Display1 D1 positive
184	HDMI0_TX0_N	Output HDMI0 TX0 negative
185	GND	Ground (0V)
186	GND	Ground (0V)
187	DSI1_C_N	Output Display1 clock negative
188	HDMI0_CLK_P	Output HDMI0 clock positive
189	DSI1_C_P	Output Display1 clock positive
190	HDMI0_CLK_N	Output HDMI0 clock negative
191	GND	Ground (0V)
192	GND	Ground (0V)
193	DSI1_D2_N	Output Display1 D2 negative
194	DSI1_D3_N	Output Display1 D3 negative
195	DSI1_D2_P	Output Display1 D2 positive
196	DSI1_D3_P	Output Display1 D3 positive
197	GND	Ground (0V)
198	GND	Ground (0V)
199	HDMI0_SDA	Bidirectional HDMI0 SDA. Internally pulled up with a 1.8kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)
200	HDMI0_SCL	Bidirectional HDMI0 SCL. Internally pulled up with a 1.8kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the CM4 by an on-board HDMI05-CL02F3)

All ground pins should be connected. If none of the signals on the second connector (pins 101 to 200) are used, then you may omit the connector to reduce costs, but mechanical stability needs to be considered.

The voltage on GPIO pins 0-27 must not exceed `CM4_3.3V` if +3.3V signalling is used or `CM4_1.8V` if +1.8V signalling is used. These pins are the same as on the 40-pin connector on the Raspberry Pi 4 Model B.

If the `CM4_1.8V` rail is used to power other devices other than the `GPIO_VREF` then you should ensure that in case of surprise power removal (e.g.the +5V pin goes below +4.5V) from the CM4, the load on the `CM4_1.8V` must go to zero.

Similarly if the `CM4_3.3V` rail is used to power other devices other than the `GPIO_VREF`, then you should ensure that in the case of surprise power removal the `CM4_3.3V` rail never falls below the `CM4_1.8V` rail. This is the typical case, but you should check this in your design. In the case where it does fall below the `CM4_1.8V` rail, then extra circuitry is required to disconnect the `CM4_3.3V` load.

No reverse voltage must be applied to any pin, or power-up may be prevented; i.e. during power-down/off no pin may have external voltage applied, otherwise this may prevent a subsequent power-up.

177	DSI1_D0_P	输出 Display1 D0 正极
178	HDMI0_TX1_N	输出 HDMI0 TX1 负极
179	GND	接地（0V）
180	GND	接地（0V）
181	DSI1_D1_N	输出 Display1 D1 负极
182	HDMI0_TX0_P	输出 HDMI0 TX0 正极
183	DSI1_D1_P	输出 Display1 D1 正极
184	HDMI0_TX0_N	输出 HDMI0 TX0 负极
185	GND	接地（0V）
186	GND	接地（0V）
187	DSI1_C_N	输出 Display1 时钟 负极
188	HDMI0_CLK_P	输出 HDMI0 时钟 正极
189	DSI1_C_P	输出 Display1 时钟 正极
190	HDMI0_CLK_N	输出 HDMI0 时钟 负极
191	GND	接地（0V）
192	GND	接地（0V）
193	DSI1_D2_N	输出 Display1 D2 负极
194	DSI1_D3_N	输出 Display1 D3 负极
195	DSI1_D2_P	输出 Display1 D2 正极
196	DSI1_D3_P	输出 Display1 D3 正极
197	GND	接地（0V）
198	GND	接地（0V）
199	HDMI0_SDA	双向 HDMI0 SDA，引脚内部通过 1.8kΩ 上拉，5V 兼容。（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）
200	HDMI0_SCL	双向 HDMI0 SCL，引脚内部通过 1.8kΩ 上拉，5V 兼容。（可直接连接HDMI连接器；CM4板载HDMI05-CL02F3提供有限的ESD保护）

所有接地引脚均应连接。若第二连接器（引脚 101 至 200）上的信号未被使用，可省略该连接器以降低成本，但需考虑机械稳定性。

当使用+3.3V 信号时，GPIO引脚0-27上的电压不得超过 CM4_3.3V；若使用+1.8V 信号，则不得超过 CM4_1.8V。
这些引脚与Raspberry Pi 4 型 B 上40针连接器的引脚相同。

如果CM4_1.8V轨用于为除GPIO_VREF以外的其他设备供电，则应确保在意外断电（例如+5V 引脚低于+4.5V）情况下，CM4_1.8V的负载必须降为零。

同样，如果 CM4_3.3V轨用于为除GPIO_VREF以外的其他设备供电，则应确保在意外断电情况下， CM4_3.3V轨的电压绝不低于 CM4_1.8V轨。这是典型情况，但您应在设计中加以确认。如果电压确实降至 CM4_1.8V电轨以下，则需额外电路以断开 CM4_3.3V负载。

任何引脚不得施加反向电压，否则可能导致无法上电；即在断电或关机状态下，任何引脚不得施加外部电压，否则可能阻止后续上电。

4.1. Differential pairs

It is recommended that P/N signals within a pair are matched to better than 0.15mm. Often, matching between pairs is not so critical: e.g. HDMI pair-to-pair matching should be better than 25mm, so on a typical board no extra matching is required.

4.1.1. 100Ω differential pair signal lengths

On the CM4 all differential pairs are matched to better than 0.05mm (P/N signals).

NOTE

It is recommended that pairs are also matched on the interface board.

On the CM4, pair-to-pairs are not always matched, as many interfaces do not require very accurate matching between pairs. Table 7 documents the CM4 track-length difference within each group. (A non-zero value represents how much longer in mm that track is, when compared to the signal with zero length difference.)

Table 7. 100Ω differential pair signal lengths

Signal	Length
CAM0_C_N	0.02
CAM0_C_P	0.02
CAM0_D0_N	0.06
CAM0_D0_P	0.07
CAM0_D1_N	0
CAM0_D1_P	0.01
CAM1_C_N	0.78
CAM1_C_P	0.78
CAM1_D0_N	0.02
CAM1_D0_P	0.01
CAM1_D1_N	0.4
CAM1_D1_P	0.4
CAM1_D2_N	0.05
CAM1_D2_P	0.04
CAM1_D3_N	0.01
CAM1_D3_P	0
DSI0_C_N	0
DSI0_C_P	0
DSI0_D0_N	0
DSI0_D0_P	0
DSI0_D1_N	0.01
DSI0_D1_P	0.01

4.1. 差分对

建议差分对中的P/N信号匹配度优于0.15mm。通常，差分对之间的匹配要求不那么严格：例如，HDMI差分对间的匹配应优于25mm，因此在典型电路板上无需额外匹配。

4.1.1. 100Ω 差分对信号长度

在CM4上，所有差分对的P/N信号匹配度均优于0.05mm。

注意

建议在接口板上也进行差分对的匹配。

在CM4上，差分对之间的匹配并非始终严格，因为许多接口不需极为精准的差分对间匹配。表7记录了CM4各组内部的走线长度差异。（非零值表示该走线比零长度差异的信号多出的毫米数。）

表7. 100Ω 差分对信号长度

信号	长度
CAM0_C_N	0.02
CAM0_C_P	0.02
CAM0_D0_N	0.06
CAM0_D0_P	0.07
CAM0_D1_N	0
CAM0_D1_P	0.01
CAM1_C_N	0.78
CAM1_C_P	0.78
CAM1_D0_N	0.02
CAM1_D0_P	0.01
CAM1_D1_N	0.4
CAM1_D1_P	0.4
CAM1_D2_N	0.05
CAM1_D2_P	0.04
CAM1_D3_N	0.01
CAM1_D3_P	0
DSI0_C_N	0
DSI0_C_P	0
DSI0_D0_N	0
DSI0_D0_P	0
DSI0_D1_N	0.01
DSI0_D1_P	0.01

DSI1_C_N	1.28
DSI1_C_P	1.28
DSI1_D0_N	0
DSI1_D0_P	0.01
DSI1_D1_N	1.06
DSI1_D1_P	1.06
DSI1_D2_N	0.83
DSI1_D2_P	0.84
DSI1_D3_N	3.78
DSI1_D3_P	3.79
HDMI0_CLK_N	3.25
HDMI0_CLK_P	3.24
HDMI0_TX0_N	1.76
HDMI0_TX0_P	1.76
HDMI0_TX1_N	0.62
HDMI0_TX1_P	0.62
HDMI0_TX2_N	0
HDMI0_TX2_P	0
HDMI1_CLK_N	2.47
HDMI1_CLK_P	2.46
HDMI1_TX0_N	1.51
HDMI1_TX0_P	1.51
HDMI1_TX1_N	1
HDMI1_TX1_P	1
HDMI1_TX2_N	0
HDMI1_TX2_P	0.01
Ethernet_Pair0_P	5.23
Ethernet_Pair0_N	5.23
Ethernet_Pair1_P	0
Ethernet_Pair1_N	0
Ethernet_Pair2_P	3.82
Ethernet_Pair2_N	3.82
Ethernet_Pair3_P	4.29
Ethernet_Pair3_N	4.29

DSI1_C_N	1.28
DSI1_C_P	1.28
DSI1_D0_N	0
DSI1_D0_P	0.01
DSI1_D1_N	1.06
DSI1_D1_P	1.06
DSI1_D2_N	0.83
DSI1_D2_P	0.84
DSI1_D3_N	3.78
DSI1_D3_P	3.79
HDMI0_CLK_N	3.25
HDMI0_CLK_P	3.24
HDMI0_TX0_N	1.76
HDMI0_TX0_P	1.76
HDMI0_TX1_N	0.62
HDMI0_TX1_P	0.62
HDMI0_TX2_N	0
HDMI0_TX2_P	0
HDMI1_CLK_N	2.47
HDMI1_CLK_P	2.46
HDMI1_TX0_N	1.51
HDMI1_TX0_P	1.51
HDMI1_TX1_N	1
HDMI1_TX1_P	1
HDMI1_TX2_N	0
HDMI1_TX2_P	0.01
Ethernet_Pair0_P	5.23
Ethernet_Pair0_N	5.23
Ethernet_Pair1_P	0
Ethernet_Pair1_N	0
Ethernet_Pair2_P	3.82
Ethernet_Pair2_N	3.82
Ethernet_Pair3_P	4.29
Ethernet_Pair3_N	4.29

4.1.2. 90Ω differential pair signal lengths

On the CM4 all differential pairs are matched to better than 0.05mm (P/N signals).

NOTE

It is recommended that pairs are also matched on the interface board.

Pair-to-pairs aren't always matched as many interfaces don't require very accurate matching between pairs. Table 8 documents the CM4 track-length difference within each group. (A non-zero value represents how much longer in mm that track is, when compared to the signal with zero length difference.)

Table 8. 90Ω differential pair signal lengths

Signal	Length
PCIe_CLK_P	0.65
PCIe_CLK_N	0.65
PCIe_TX_P	0
PCIe_TX_N	0
PCIe_RX_P	0.23
PCIe_RX_N	0.23
USB2_P	0
USB2_N	0

4.1.2. 90Ω 差分对信号长度

在CM4上，所有差分对的P/N信号匹配度均优于0.05mm。

注意

建议在接口板上也进行差分对的匹配。

对间走线长度不总是匹配，因为许多接口不要求对间有非常精确的匹配。表8记录了CM4各组内部的走线长度差异。（非零值表示该走线比零长度差异的信号多出的毫米数。）

表8. 90Ω 差分对信号长度

信号	长度
PCIe_CLK_P	0.65
PCIe_CLK_N	0.65
PCIe_TX_P	0
PCIe_TX_N	0
PCIe_RX_P	0.23
PCIe_RX_N	0.23
USB2_P	0
USB2_N	0

Chapter 5. Power

5.1. Power-up sequencing

The CM4 requires a single +5V supply, and can supply up to 600mA at +3.3V and +1.8V to peripherals.

All pins should not have any power applied to them before the +5V rail is applied.

If the EEPROM is to be write-protected, then the `EEPROM_nWP` should be low before power-up.

If the CM4 is to be booted using USB then `RPI_nBOOT` needs to be low within 2ms of +5V rising.

+5V should rise monotonically to 4.75V and stay above 4.75V for the entire operation of the CM4.

The power-up sequence will start when both +5V rail is above 4.75V and `GLOBAL_EN` rises. `GLOBAL_EN` has internal RC delay so that it rises after +5V has risen. The order of events is as follows

1. +5V rises
2. `GLOBAL_EN` rises
3. +3.3V rises
4. +1.8V rises at least 1ms after +3.3V
5. `RUN_PG` rises at least 10ms after +1.8V
6. `EXT_nRESET` rises at least 1s after `RUN_PG`

5.2. Power-down sequencing

The operating system should be shut down before the power is removed, to ensure that the file system remains consistent. If this can't be achieved, then a filesystem like `btrfs`, `f2fs` or `overlayfs` (use `raspi-config` to enable this) should be considered.

Once the operating system has shut down, the +5V rail can be removed or the `GLOBAL_EN` pin can be taken low to put the CM4 into the lowest power mode.

During the shutdown sequence the +1.8V will be discharged before the +3.3V rail.

5.3. Power consumption

The exact power consumption of the CM4 will greatly depend on the tasks being run on the CM4. The lowest shutdown power consumption mode is with the `GLOBAL_EN` driven low, typically is 15µA. With `GLOBAL_EN` high but software shut down, the typical consumption is 8mA. Idle power consumption is typically 400mA, but this varies considerably depending on the operating system. Operating power consumption is typically around 1.4A; again, this greatly depends on the operating system and the tasks being executed.

5.4. Regulator outputs

To make it easier to interface to the CM4 the on-board regulators (+3.3V and +1.8V) can each supply 600mA to devices connected to the CM4. The loads on these outputs isn't taken into account in the power consumption figures.

第5章 电源

5.1. 上电顺序

CM4需要单一+5V电源，并可向外设提供最高600mA的+3.3V及+1.8V电源。

所有引脚在施加+5V电源前，不应有任何电源施加。

如果EEPROM需要写保护，则EEPROM_nWP应在上电前保持低电平。

若CM4通过USB启动，则RPI_nBOOT需在+5V电源上升后2ms内拉低。

+5V 电压应单调升至 4.75V，并在 CM4 运行期间持续保持高于 4.75V。

当 +5V 电压超过 4.75V 且 GLOBAL_EN上升时，电源启动序列将开始。 GLOBAL_EN具有内部 RC 延迟，因此其上升时间晚于 +5 V 上升时间。事件顺序如下：1. +5V 上升

2. GLOBAL_EN 上升
3. +3.3V 上升
4. +1.8V 在 +3.3V 上升至少 1 毫秒后升高
5. RUN_PG 在 +1.8V 之后至少 10 毫秒上升
6. EXT_nRESET在 RUN_PG上升至少 1 秒后上升

5.2. 断电顺序

应在断电之前关闭操作系统，以确保文件系统保持一致性。如果无法实现，应考虑使用如 btrfs、 f2fs或 overlayfs的文件系统（通过raspi-config启用）。

操作系统关闭后，可断开+5V电源轨，或将 GLOBAL_EN引脚拉低，使CM4进入最低功耗模式。

在关机序列中，+1.8V电源轨会先于+3.3V电源轨放电。

5.3. 功耗

CM4的具体功耗因运行任务而异。最低关机功耗模式为 GLOBAL_EN被拉低时，典型功耗为15μA。 当 GLOBAL_EN为高且软件已关闭时，典型功耗为8mA。 空闲功耗典型值约为400mA，但根据操作系统不同变化较大。运行功耗典型值约为1.4A； 同样，功耗受操作系统及运行任务的显著影响。

5.4. 稳压器输出

为方便连接CM4，板载稳压器（+3.3V和+1.8V）各可为连接设备提供600mA电流。此类负载未计入功耗统计中。

Appendix A: Troubleshooting

The CM4 has a number of stages of power-up before the CPU starts. If there is an error at any of the stages, power-up will be halted.

Hardware checklist

1. Is the +5V supply good? Check this by pulling `GLOBAL_EN` low and apply an external 2A load to the +5V supply. Does it stay > +4.75V including noise? Ideally it should remain > +4.9V including any noise.
2. Remove external 2A load, but keep `GLOBAL_EN` pulled low.
3. Check the CM4 +3.3V rail is < 200mV. If this is not the case there is an external power path back-feeding the CM4, either directly or indirectly. This could also occur via the digital pins, e.g Ethernet.
4. Still with `GLOBAL_EN` pulled low check the CM4 +1.8V rail is < 200mV. Again if the +1.8V rail is above 200mV then there is an external path back-feeding the 1.8V rail. (If nothing is connected to these pins you can ignore this check.)
5. Remove the pull down on `GLOBAL_EN`.
6. Check `GLOBAL_EN` now goes high (it is internally pulled up on the CM4)
7. Check the +3.3V supply rises to > +3.15V. If it does not, this suggests there is too much load on the +3.3V rail.
8. Check the +1.8V rail gets to > +1.71V. If it does not, this suggests there is too much load on the +1.8V rail.
9. Check `RUN_PG` goes high
10. Check `ACT_LED` starts to oscillate to indicate booting; check it isn't flashing an error code.

Bootloader

1. Connect a HDMI cable to see if the HDMI diagnostics screen appears.
2. Connect a USB serial cable to GPIO pins 14 and 15.
    a. See https://www.raspberrypi.com/documentation/computers/configuration.html#configuring-uarts for details.
3. Short the `nRPIBOOT` pin to ground to force USB boot mode. The CM4IO board has a jumper for `nRPIBOOT` This can be used to enable different boot modes (e.g. network) and enable UART logging.
    a. See https://www.raspberrypi.com/documentation/computers/compute-module.html#flashing-the-compute-module-emmc

rpi-eeprom-update

1. CM4 will not run `recovery.bin` from from the EMMC (or SD Card on CM4Lite). Therefore, the only way to update the bootloader EEPROM is via `usbboot` or self-update.

EEPROM write-protect

The on-board EEPROM can be write-protected by shorting `EEPROM_nWP` to ground. The CM4IO board has a jumper for

附录 A：故障排除

CM4 在 CPU 启动之前经历多个上电阶段。如果任何阶段出现错误，上电过程将被中止。

硬件检查清单

1. +5V 电源是否正常？通过将 GLOBAL_EN拉低并对 +5V 电源施加外部 2A 负载进行检测。电压是否保持高于 +4.75V（含噪声）？ 理想情况下，应保持高于 +4.9V（含所有噪声）。
2. 移除外部 2A 负载，但保持 GLOBAL_EN拉低状态。
3. 检查 CM4 +3.3V 电源轨电压是否低于 200mV。 如果不是，则存在外部电源路径直接或间接地向 CM4 反向供电。这也可能通过数字引脚发生，例如以太网。
4. 继续保持 GLOBAL_EN拉低，检查 CM4 +1.8V 电源轨电压是否低于 200mV。 同样，如果 +1.8V 电源轨电压高于 200mV，则存在外部路径向 +1.8V 电源轨反向供电。（如果这些引脚未连接任何设备，可忽略此项检查。）
5. 移除 GLOBAL_EN上的下拉电阻。
6. 检查 GLOBAL_EN是否变为高电平（CM4 内部已上拉）。
7. 检查 +3.3V 电源是否升至 > +3.15V。若未达到，可能表示 +3.3V 电源轨负载过重。
8. 检查 +1.8V 电源轨是否升至 > +1.71V。若未达到，可能表示 +1.8V 电源轨负载过重。
9. 检查 RUN_PG是否变为高电平。
10. 检查 ACT_LED是否开始闪烁以指示启动；确认其未闪烁错误代码。

引导加载程序

1. 连接 HDMI 电缆，确认是否显示 HDMI 诊断屏幕。
2. 将 USB 串口线连接至 GPIO 引脚 14 和 15。
    a. 详情请参见 https://www.raspberrypi.com/documentation/computers/configuration.html#configuring-uarts 。
3. 将 nRPIBOOT引脚短接至地，以强制进入 USB 启动模式。CM4IO 板载跳线用于 nRPIBOOT。该跳线可用于启用不同的启动模式（例如网络启动）及启用 UART 通用异步收发器日志记录。
    a. 请参考 https://www.raspberrypi.com/documentation/computers/compute-module.html#flashing-the-compute-module-emmc

rpi-eeprom-update

1. CM4 不会从 EMMC（或 CM4Lite 的 SD 卡）运行recovery.bin。因此，更新引导加载程序 EEPROM 的唯一方式为通过 usbboot或自我更新。

EEPROM 写保护

通过将 EEPROM_nWP短接至地，可对板载 EEPROM 进行写保护。CM4IO 板载跳线用于

`EEPROM_nWP`.

1. See https://www.raspberrypi.com/documentation/computers/raspberry-pi.html#raspberry-pi-4-bootloader-configuration

Firmware

1. A 5.4 or newer kernel and the latest firmware release is required. These can be updated by using usbboot to mount the EMMC as a USB MSD device.
2. Nightly OS images are now available which contain `rpi-update` master firmware + kernel. Bug fixes for CM4 will normally be provided via these images except where a test/patch binary is required.
    a. See http://downloads.raspberrypi.org/nightlies/

Kernel

1. The updated OS images use the new Raspberry Pi Compute Module 4 device tree file. If that is not found then the Raspberry Pi 4 Model B device tree file will be used.
    a. See https://github.com/raspberrypi/linux/blob/rpi-5.4.y/arch/arm/boot/dts/bcm2711-rpi-cm4.dts

`EEPROM_nWP`

1. 请参考 https://www.raspberrypi.com/documentation/computers/raspberry-pi.html#raspberry-pi-4-bootloader-configuration

固件

1. 需要 5.4 版本或以上内核及最新固件版本。这些可通过使用 usbboot 将 EMMC 挂载为 USB MSD 设备进行更新。

2. 现已提供包含 `rpi-update` 主固件及内核的夜间操作系统镜像。除需测试或补丁二进制文件的特殊情况外，CM4 的错误修复通常通过这些镜像提供。

    a. 请访问 http://downloads.raspberrypi.org/nightlies/

内核

1. 更新后的操作系统镜像采用了新的 Raspberry Pi 计算模块 4 设备树文件。若未找到该文件，则使用 Raspberry Pi 4 型 B 设备树文件。

    a. 详见 https://github.com/raspberrypi/linux/blob/rpi-5.4.y/arch/arm/boot/dts/bcm2711-rpi-cm4.dts

Appendix B: Availability

Support

For documentation please see the Compute Module Hardware documentation section of the Raspberry Pi website. Support questions can be posted to the Raspberry Pi forum.

Ordering codes

Table 9. Part number options

Model	Wireless	RAM LPDDR4	eMMC Storage
CM4	0 = No	01 = 1GB	000 = 0GB (Lite)
	1 = Yes	02 = 2GB	008 = 8GB
		04 = 4GB	016 = 16GB
		08 = 8GB	032 = 32GB
Example Part Number			
CM4	1	02	032

Table 10. Ordering options

Wireless	RAM LPDDR4	Storage eMMC	RPL #	Part Number	Order Multiple	RRP
-	1GB	Lite	SC0695B	CM4001000	1+ / Bulk	$ 30.00
-	1GB	8GB	SC0696B	CM4001008	1+ / Bulk	$ 35.00
-	1GB	16GB	SC0697B	CM4001016	1+ / Bulk	$ 40.00
-	1GB	32GB	SC0698B	CM4001032	1+ / Bulk	$ 45.00
Yes	1GB	Lite	SC0691B	CM4101000	1+ / Bulk	$ 35.00
Yes	1GB	8GB	SC0692B	CM4101008	1+ / Bulk	$ 40.00
Yes	1GB	16GB	SC0693B	CM4101016	1+ / Bulk	$ 45.00
Yes	1GB	32GB	SC0694B	CM4101032	1+ / Bulk	$ 50.00
-	2GB	Lite	SC0679B	CM4002000	1+ / Bulk	$ 35.00
-	2GB	8GB	SC0680B	CM4002008	1+ / Bulk	$ 40.00
-	2GB	16GB	SC0681B	CM4002016	1+ / Bulk	$ 45.00
-	2GB	32GB	SC0682B	CM4002032	1+ / Bulk	$ 50.00
Yes	2GB	Lite	SC0667B	CM4102000	1+ / Bulk	$ 40.00
Yes	2GB	8GB	SC0668B	CM4102008	1+ / Bulk	$ 45.00
Yes	2GB	16GB	SC0669B	CM4102016	1+ / Bulk	$ 50.00
Yes	2GB	32GB	SC0670B	CM4102032	1+ / Bulk	$ 55.00
-	4GB	Lite	SC0683B	CM4004000	1+ / Bulk	$ 50.00
-	4GB	8GB	SC0684B	CM4004008	1+ / Bulk	$ 55.00

附录 B：供应情况

支持

有关文档，请参阅 Raspberry Pi 网站上的计算模块硬件文档部分。支持问题可发布至 Raspberry Pi 论坛。

订购代码

表 9. 零件编号选项

型号	无线	内存 LPDDR4	eMMC 存储
CM4	0 = 无	01 = 1GB	000 = 0GB（精简版）
	1 = 是	02 = 2GB	008 = 8GB
		04 = 4GB	016 = 16GB
		08 = 8GB	032 = 32GB
示例零件编号			
CM4	1	02	032

表 10. 订购选项

无线	内存 LPDDR4	存储 eMMC	RPL编号	零件编号	订购倍数	建议零售价
-	1GB	精简版	SC0695B	CM4001000	1+ / 散装	$ 30.00
-	1GB	8GB	SC0696B	CM4001008	1+ / 散装	$ 35.00
-	1GB	16GB	SC0697B	CM4001016	1+ / 散装	$ 40.00
-	1GB	32GB	SC0698B	CM4001032	1+ / 散装	$ 45.00
是	1GB	精简版	SC0691B	CM4101000	1+ / 散装	$ 35.00
是	1GB	8GB	SC0692B	CM4101008	1+ / 散装	$ 40.00
是	1GB	16GB	SC0693B	CM4101016	1+ / 散装	$ 45.00
是	1GB	32GB	SC0694B	CM4101032	1+ / 散装	$ 50.00
-	2GB	精简版	SC0679B	CM4002000	1+ / 散装	$ 35.00
-	2GB	8GB	SC0680B	CM4002008	1+ / 散装	$ 40.00
-	2GB	16GB	SC0681B	CM4002016	1+ / 散装	$ 45.00
-	2GB	32GB	SC0682B	CM4002032	1+ / 散装	$ 50.00
是	2GB	精简版	SC0667B	CM4102000	1+ / 散装	$ 40.00
是	2GB	8GB	SC0668B	CM4102008	1+ / 散装	$ 45.00
是	2GB	16GB	SC0669B	CM4102016	1+ / 散装	$ 50.00
是	2GB	32GB	SC0670B	CM4102032	1+ / 散装	$ 55.00
-	4GB	精简版	SC0683B	CM4004000	1+ / 散装	$ 50.00
-	4GB	8GB	SC0684B	CM4004008	1+ / 散装	$ 55.00

-	4GB	16GB	SC0685B	CM4004016	1+ / Bulk	$ 60.00
-	4GB	32GB	SC0686B	CM4004032	1+ / Bulk	$ 65.00
Yes	4GB	Lite	SC0671B	CM4104000	1+ / Bulk	$ 55.00
Yes	4GB	8GB	SC0672B	CM4104008	1+ / Bulk	$ 60.00
Yes	4GB	16GB	SC0673B	CM4104016	1+ / Bulk	$ 65.00
Yes	4GB	32GB	SC0674B	CM4104032	1+ / Bulk	$ 70.00
-	8GB	Lite	SC0687B	CM4008000	1+ / Bulk	$ 75.00
-	8GB	8GB	SC0688B	CM4008008	1+ / Bulk	$ 80.00
-	8GB	16GB	SC0689B	CM4008016	1+ / Bulk	$ 85.00
-	8GB	32GB	SC0690B	CM4008032	1+ / Bulk	$ 90.00
Yes	8GB	Lite	SC0675B	CM4108000	1+ / Bulk	$ 80.00
Yes	8GB	8GB	SC0676B	CM4108008	1+ / Bulk	$ 85.00
Yes	8GB	16GB	SC0677B	CM4108016	1+ / Bulk	$ 90.00
Yes	8GB	32GB	SC0678B	CM4108032	1+ / Bulk	$ 95.00

NOTE

RRP was correct at time of publication and excludes taxes.

Packaging

Small quantities are supplied in individual cardboard boxes. These have an internal ESD coating so that a separate ESD bag isn't required. This packaging is recyclable and reduces waste.

-	4GB	16GB	SC0685B	CM4004016	1+ / 散装	$ 60.00
-	4GB	32GB	SC0686B	CM4004032	1+ / 散装	$ 65.00
是	4GB	精简版	SC0671B	CM4104000	1+ / 散装	$ 55.00
是	4GB	8GB	SC0672B	CM4104008	1+ / 散装	$ 60.00
是	4GB	16GB	SC0673B	CM4104016	1+ / 散装	$ 65.00
是	4GB	32GB	SC0674B	CM4104032	1+ / 散装	$ 70.00
-	8GB	精简版	SC0687B	CM4008000	1+ / 散装	$ 75.00
-	8GB	8GB	SC0688B	CM4008008	1+ / 散装	$ 80.00
-	8GB	16GB	SC0689B	CM4008016	1+ / 散装	$ 85.00
-	8GB	32GB	SC0690B	CM4008032	1+ / 散装	$ 90.00
是	8GB	精简版	SC0675B	CM4108000	1+ / 散装	$ 80.00
是	8GB	8GB	SC0676B	CM4108008	1+ / 散装	$ 85.00
是	8GB	16GB	SC0677B	CM4108016	1+ / 散装	$ 90.00
是	8GB	32GB	SC0678B	CM4108032	1+ / 散装	$ 95.00

注意

建议零售价在发布时准确，且不含税。

包装

少量产品采用单独的纸板箱包装。包装内层具有防静电涂层，因此无需另行使用防静电袋。该包装可回收利用，旨在减少废弃物产生。